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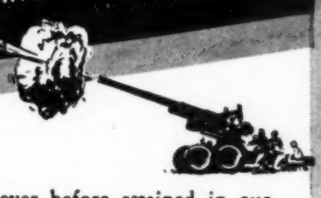

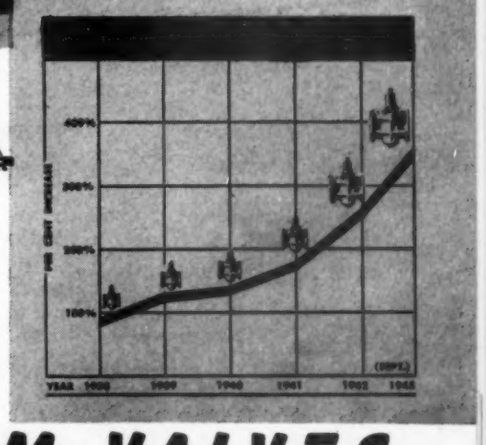

Merco Nordstrom Valve Company, in common with the entire valve industry, is emerging from a very trying period. Earlier this year the need for valves in vital wartime industries greatly exceeded all available facilities. Nordstrom was ordered to produce 600% over normal capacity during a short period and then was confronted with shortages ranging from man-power and machine tools through storage facilities and materials. These handicaps, we are pleased to report, have now been largely eliminated—thanks to a realization on the part of the War Production Board of the indispensable and unique position occupied by Nordstrom Valves.

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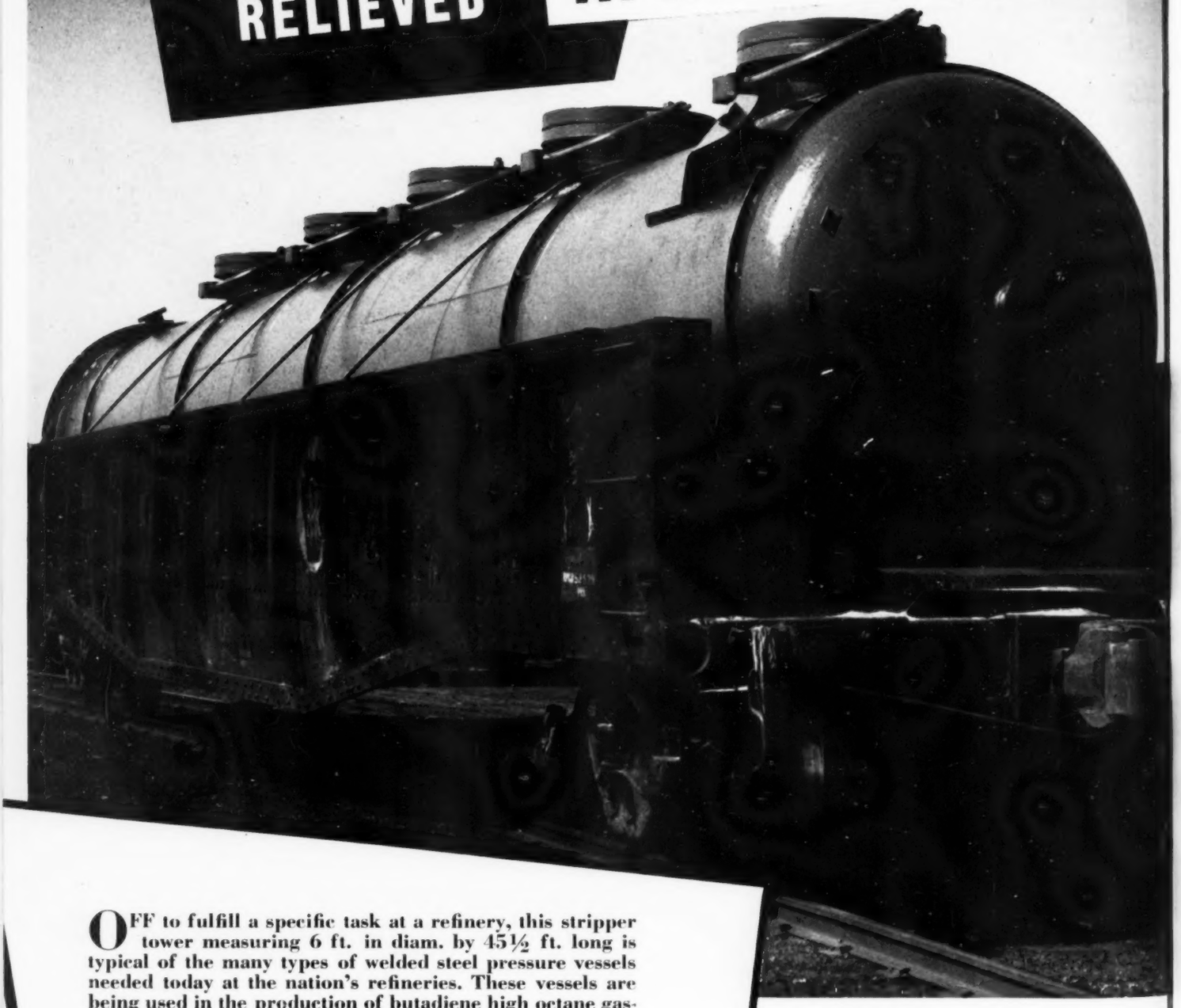

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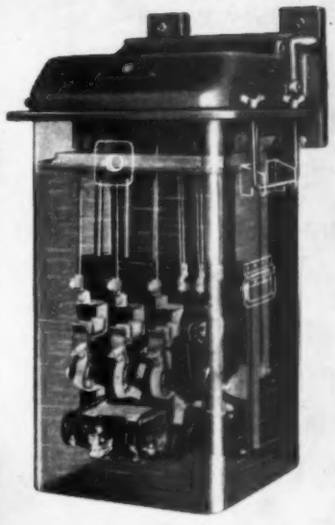

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MEMBER A.B.C.—A.B.P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.)

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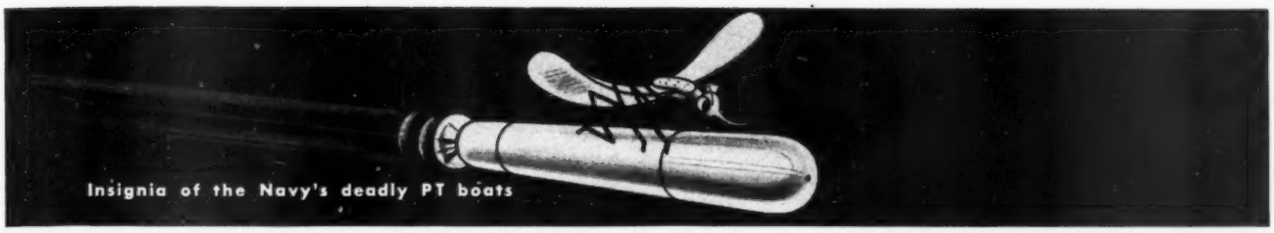

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The Course of Oil

by K. C. SCLATER

PETROLEUM RESERVES CORPORATION

Participation by the United States Government in foreign oil operations has been roundly assailed by Senator E. H. Moore of Oklahoma. In a statement issued at Chicago during the annual meeting of the American Petroleum Institute this month, Senator Moore said in part, "The newest instrumentality for embarking the government in the oil business is the Petroleum Reserves Corporation, a government corporation organized to put the government in the oil business in every corner of the globe. It was created June 30, 1943, under authority of RFC. It has a million dollar capital, but an unlimited power to borrow money from the government. It will be operating in competition with American private capital, and in competition with the governments and citizens of countries in which it has or will acquire petroleum interests. It has the authority to buy stock in other corporations, and of course it will have the authority to absorb such projects as the Fort Norman project.

"The PRC has come into existence through queer secrecy. It means to go into business without the knowledge of Congress, or the people. It will be the initiation of a new economic foreign policy which can have greater adverse future effects upon the people of this nation than any action ever taken in the past.

"It has the power to engage in refining, transportation and marketing abroad and at home, and is likely to lead the U. S. Government into the commercial oil business in many parts of the world and at home.

"This puts our government into the same category with that of Britain, France, Argentina, Mexico, and Russia, which have government monopolies, owned and managed. It is an unwholesome policy and will no doubt be a source of further disputes among governments and will contribute to those international feelings which help to arouse national pride and hatreds and produce wars. For our government to own property in foreign countries, within their borders, is likely to be looked upon with suspicion by a peaceful world."

This is a significant statement, coming as it does, from a member of the United States Senate. It is symptomatic of the suspicion and apprehension that pervades the oil industry in regard to participation by the U. S. Government in foreign oil operations. Even Petroleum Administrator Ickes took cognizance of a rising tide of apprehension on this question when he commented at some length on it in his address before the American Petroleum Institute, Noyember 11 in Chicago. He said, "With respect to the Petroleum Reserves Corporation, there seems to have been a great deal of misguided and inaccurate speculation as to its purposes and future course of conduct. Actually, there is no occasion for the type of rumors which have come to my ears. Petroleum Reserves Corporation is in no sense the first, although so far as I know it was the latest, of the governmental corporations which the war has compelled us to create to meet our national needs for critical materials.

"In order to protect business here in the United States, to assure the American people of enough oil to meet their needs, and to make certain that there is sufficient oil for military requirements, it is necessary that the United States obtain a fair measure of access to foreign oil resources. We will be able to make available within our present reserves enough oil to finish this global war, but we couldn't possibly oil another war of this size. In view of this fact we would be remiss in our duty and indifferent about the future of our country if we did not adopt measures to assure ourselves oil in the event of another world war.

"At the present time, there is no international arrangement which adequately carries out the principles of the Atlantic Charter so as to guarantee to the nations of the world fair access to the world's oil resources. It is hoped that some such agreement will be forthcoming. A program of this sort would contribute greatly to the peace and security of all nations.

"In the past, a number of United States oil companies have established themselves in the foreign oil business. They have obtained rights to oil reserves; they have constructed facilities to process and transport oil, and they have engaged in worldwide distribution of oil and its products. This has been done entirely as a result of private initiative with the government extending its good offices. On the other hand, the principal nations of the world—or most of them—have conducted their foreign oil business through corporations or agencies which are entirely or partly owned or in effect controlled by the government itself. The United States is one of the few major countries which has not participated in foreign oil activities through governmental financing or direction.

"To the extent that private capital and private initiative are unable to establish and maintain a national position in this field, government assistance and participation may be necessary. The Petroleum Reserves Corporation is available for these purposes whenever and wherever necessary. The Directors of the Corporation are the Secretaries of State, War, Navy and Interior, and the Administrator of the Foreign Economic Administration."

Despite Mr. Ickes' statement, the potential role of Petroleum Reserves Corporation in foreign oil has many implications. Some of these have been voiced by Senator Moore. The bald statement of Mr. Ickes, that government assistance and participation may be necessary to the extent that private capital and private initiative are unable to establish and maintain a national position in world oil, needs to be amplified. A comprehensive and frank statement from Washington on the ultimate aims of government in regard to foreign oil and a foreign oil policy, is due the oil industry.

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Highlights IN OILDOM

Foreign Oil Production

Heretofore confidential, figures on foreign oil production recently were announced by the Petroleum Administration for War. Crude oil production in the Middle East and India, of which 79.54 percent is controlled by British interests, is estimated to be 345,200 bbl. a day, about 8 percent of the daily production in the United States.

Production of the major anti-Axis areas outside the United States—the Middle East, India, and Latin-America—is approximately 1,276,720 bbl. a day, less than 30 percent of the estimated daily output of 4,350,000 bbl. in the United States.

American interests, according to the figures, control 15.3 percent of the oil producing areas in the Middle East—100 percent of those in Saudi Arabia, 100 percent of those in Bahrein Island, a British mandated island in the Persian Gulf, and 23.75 percent of those in Iraq.

Middle East production figures show that the oil fields in Bahrein Island produce 20,000 bbl. a day; Egypt, 25,000 bbl.; India, 7,500 bbl.; Iran, 200,000 bbl.; Iraq, 75,000 bbl.; Saudi Arabia, 15,000 bbl., and other United Kingdom holdings 2,700 bbl.

The figures revealed that of the countries supplementing United States deliveries of oil to the fighting fronts, Venezuela is the largest contributor, producing approximately 585,000 bbl. a day. Eighty percent of Venezuela's oil resources are American-owned, the other 20 percent being controlled by the British.

PAW's figures showed that the United States controls 59.3 percent of the oil resources in Latin-America, Britain 23.6 percent, and other countries 17.1 percent. The overall figures for the Middle East, India and Latin-America show that American interests control 47.39 percent, Britain 38.73 percent, and other countries 13.88 percent.

Estimated daily production of Latin-American countries is as follows: Argentina, 68,000 bbl.; Bolivia, 800 bbl.; Brazil, 220 bbl.; Colombia, 60,000 bbl.; Ecuador, 7,500 bbl.; Mexico, 110,000 bbl.; Peru, 40,000 bbl., and Trinidad, 61,000 bbl.

Abandoned Texas Wells Exceed New Ones

For the first time in history well abandonments in Texas exceed new producers, states S. Maston Nixon, newly elected president of the Texas Mid-Continent Oil and Gas Association. Nixon, who is also chairman of the sub-committee on crude oil supply for District 3, Petroleum Administration for War, asserts that abandonments in the state this year exceed completions by more than 800.

"Texas will produce in excess of 575,000,000 bbl. of crude oil in 1943 in its all-out contribution to winning the war," he said, "but in so doing, the industry in the state is faced with many new and serious problems.

"It is obvious to anyone that the stripper well must go out of the picture when all operating costs have materially increased with no offsetting increase in the price for crude oil.

"Wages in the oil industry have risen 48 percent since 1939. Materials costs have increased 19 percent. The actual out-of-pocket costs of drilling wildcat wells have jumped 50 percent in the past two years.

"Exploratory wells this year may be up to normal in number, but with very discouraging results. For the first nine months of 1943, 84 percent of all wildcat wells were failures.

"The high percentage of failures combined with low discoveries is increasing our finding costs at an alarming rate. Recent low figures show present finding costs exceed 60 cents a bbl. When development and operating costs are added to this, Texas oil today is being sold at a definite loss. The present prices do not provide any replacement funds.

"We should be drilling twice as many wildcat wells in Texas as we are doing now. Our search for new oil can be accelerated greatly by the support of adequate price."

Compact Commission Meeting

The Interstate Oil Compact Commission will meet in the Broadview Hotel, Wichita, Kansas, December 10 and 11, for its winter quarterly meeting and annual election of officers, Governor Andrew F. Schoeppel announced.

Officers of the commission are chairman, vice chairmen, secretary, and executive committee members. Governor Schoeppel is now chairman; J. C. Hunter of Abilene, Texas, first vice chairman; Clarence T. Smith of Flora, Illinois, second vice chairman, and Charles L. Orr of Oklahoma City, Oklahoma, secretary. Present members of the executive committee are Governor Schoeppel, chairman, Governor Robert S. Kerr of Okahoma, Hiram M. Dow of New Mexico, J. C. Hunter, and Clarence T. Smith.

Questions East Texas Schedule

H. P. Nichols, executive vice president of the East Texas Oil Association, advocates that the Railroad Commission reduce the producing schedule for the East Texas field to 20 days per calendar month. On such a schedule, he says, the field could flow "consistently and indefinitely," but maintenance of the current 23-day schedule "is flirting with trouble."

"Regardless of the 2.14 lb. gain in bottom hole pressure for September, we are destined to wake up one morning and find the gas has passed out of solution and the East Texas field is a stripper proposition," Nichols said.

The transition from a flush to a stripper status would slash production 50 to 75 percent, Nichols declared, explaining: "Remembering that only one well to each ten acres can be equipped for pumping, I seriously doubt if this once great oil field could be made to produce 150,000 bbl. per day before a change could be had in existing rules."

Aviation Gasoline Program

Production of 100-octane aviation gasoline today is more than four times greater than production in the early months of 1942, and within a few months will be about eight times greater, the Petroleum Administration for War announces. Present production exceeds the 1944 goal of ultimate requirements as set by military and government authorities in the spring of 1942.

Since December 7, 1941, PAW and the oil industry have initiated 72 major 100-octane construction projects. Of these, 32 have been completed, despite delays in getting the necessary materials, and the remaining 40 will be completed within four months. Included in the program are five plants in foreign countries—Canada and the Caribbean. An additional 22 domestic plants have been scheduled in PAW's 1944 program and engineering work on these has been underway for some time.

Distinguishing the program from most other war production projects, which have been financed principally by the government, more than 75 percent of this investment is being made by the oil companies and the remainder by the Defense Plant Corporation, stated Ralph K. Davies, PAW deputy administrator.

In addition to the complete plants that have been or are being built, PAW has initiated more than 200 minor projects for changing or expanding existing facilities to increase 100-octane production, as well as production of other high octane aviation gasolines that are needed for military training.

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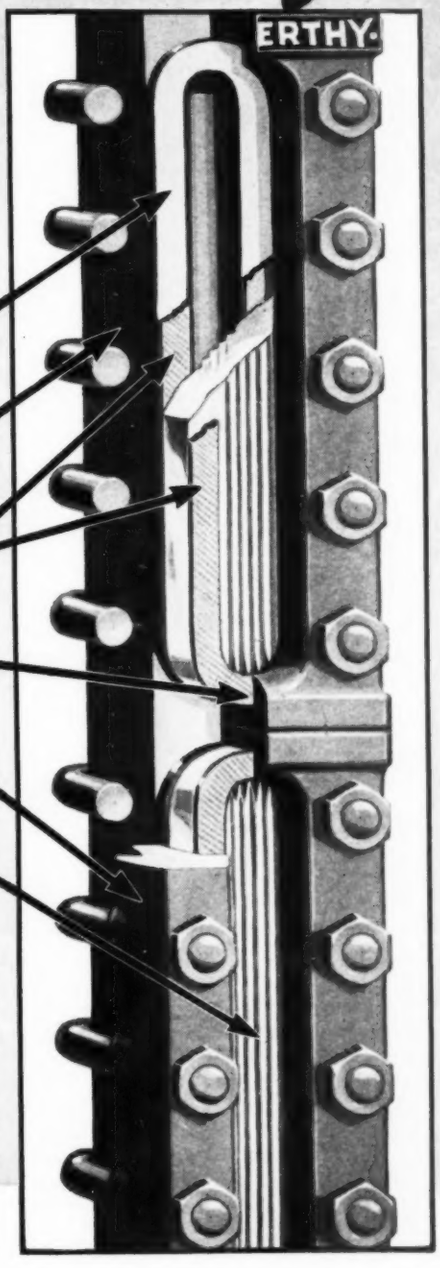

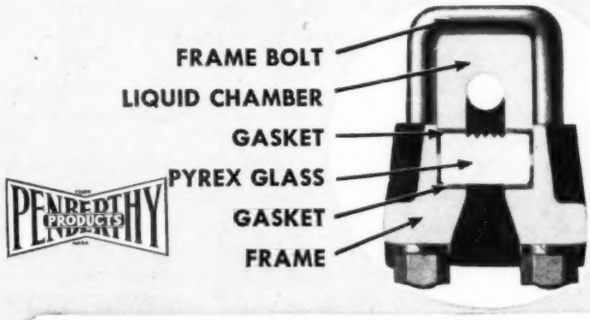

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MAJOR *Refining* ACTIVITIES

ENOUGH butadiene to produce one-seventh of the entire wartime requirement of synthetic rubber soon will be turned out in a single plant operated without profit by the oil industry, Herbert Henderson, chairman of the board of the Neches Butane Products Company, has announced. The first of two units, now almost completed at Port Neches, Texas, will be placed in operation in mid-December and the second will be ready shortly thereafter, he said.

Through a radically new process, developed by oil industry engineers, the amount of butadiene to be manufactured from a barrel of oil will be more than doubled and the refinery gases remaining after the butadience has been manufactured can be used in production of high octane gasoline and other products, he said. This process, proved in a laboratory model, has been turned over to the government and has already been found practicable in smaller plants.

The Port Neches plant, which will be the world's largest producer of butadiene, principal ingredient of synthetic rubber, is being financed by the Defense Plant Corporation. It will be operated by the Neches Butane Products Company, organized by five oil companies with refineries in the region to bring to the synthetic rubber program the combined experience and patents of the entire petroleum industry. None of the companies, Henderson pointed out, will receive any profit or management fee of any kind. In fact, he added, they are contributing the services of management and technical personnel assigned to the project and are even paying their expenses.

Refinery gases, produced in the manufacture of petroleum products, will be piped to the butadiene plant from nearby refineries of the five participating companies—The Atlantic Refining Company, Gulf Oil Corporation, The Pure Oil Company, Socony-Vacuum Oil Company, and The Texas Company. After the production of the butadiene, the remaining gases will be returned to the refineries for the production of high octane aviation gasoline and other products. The gases, or raw stock, will be supplied to the government on a cost-of-production basis.

The plant will have a capacity of 100,000 tons of butadiene a year, sufficient to produce more than 110,000 tons of synthetic rubber for the Government's Rubber Reserve Company. The nation's synthetic rubber goal is 800,000 tons. The entire rubber project at Port Neches, which consists of the butadiene plant and two copolymerization units in which the synthetic rubber is made, is government owned, although it was designed, built and will be operated by private industry.

◆

Development of Dynafuel, a super aviation fuel concentrate made entirely from petroleum and processed to produce the greatest possible power, has been announced by J. Howard Pew, president of Sun Oil Company. Pew stated that this new super aviation concentrate is 50 percent more powerful than United States standard 100-octane test fuel.

Sinclair Refining Company was refused a patent on an improved oil cracking process by the United States Court of Appeals for the District of Columbia on the grounds that the method was just an example of the natural step-by-step development of the art. The company had appealed a decision of a patents commissioner who had rejected a claim for a patent for the Smith process, which involves extremely rapid heating of petroleum. Sinclair asserted that under the Smith process the cracking reaction, by which oil is split into gasoline, kerosine, and other products, is so controlled as no longer to produce tarlike material as a byproduct. The court said that the history of oil cracking reveals steady progress in the improvement of methods and process, with the gradual cutting down of liquid residues and elimination of carbons and cokes.

◆

A new supply of high octane gasoline will be produced early next year from two large catalytic cracking units now under construction by Atlantic Refining Company. One unit is situated at the Point Breeze refinery of the company in Philadelphia and the other at its plant at Port Arthur, Texas. The newly developed fluid catalyst type of high octane manufacture will be used in both units. The plants will cost $14,000,000.

◆

J. Frank Drake, president of the Gulf Oil Corporation, has announced that the company has put into operation a thermofor catalytic cracking plant at its Port Arthur, Texas, refinery. The new units, the second of this type to be completed since its development several years ago, produce butylenes, the basic ingredient of butadiene used in the manufacture of synthetic rubber, and also a blending component of aviation grade gasoline.

The butylenes will be turned over to the nearby Neches Butane Products Company plant where it will be further processed into butadiene. This will be sold to the Goodrich and Firestone rubber companies for the manufacture of synthetic rubber.

The blending component of aviation gasoline will be used by Gulf. Drake said the amount of this material produced by the thermofor unit will be sufficient to permit the refinery to double its present output of aviation grade fuel.

In order to get the thermofor process into production as soon as possible and to conserve steel and manpower, the plant was completed by adding catalytic cracking and regenerating equipment to thermal cracking facilities heretofore used for producing motor grades of gasoline. The construction was done under high priority ratings and in close cooperation with the PAW, WPB, and Defense Plant Corporation.

The new unit is the fourth that makes products needed for war to be completed by Gulf during the past several months. It was preceded by the opening of a toluene plant at Philadelphia and by the completion of Houdry and alkylation high-octane gasoline plants at Port Arthur.

Crude Runs to Stills, Production[1] and Stocks[2] of Motor Fuels
Week Ended October 30, 1943
A.P.I. Figures
Figures in thousands of bbl. 42 gal. each)

DISTRICT	DAILY REFINING CAPACITY		CRUDE RUNS TO STILLS[3]			
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Texas	Potential Rate 2,444	Percent Reporting 88.7	Daily Average 2,108	Percent Operated 86.3	Total Production 13,401	Total Stocks 79,131
Apalachian						
District No. 1	130	83.9	102	78.5	543	3,004
District No. 2	47	87.2	49	104.3	285	1,019
Ind., Ill., Ky.	824	85.2	727	88.2	4,705	25,629
Okla., Kas., Mo.	416	80.1	347	83.4	2,184	11,018
Rocky Mt.						
District No. 3	8	26.9	8	100.0	70	140
District No. 4	141	58.3	100	70.9	605	2,215
California	817	89.9	735	90.0	5,081	67,348
TOTAL U. S.— OCT. 30, 1943	4,827	86.4	4,176	86.5	26,874	189,504
TOTAL U. S.— Oct. 23, 1943	4,827	86.4	4,160	86.2	26,378	188,505
U. S. Oct. 31, 1942	.....	.....	3,746	.....	23,888	217,329

*At the request of the Petroleum Administration for War. District No. 1 inventory indices are: Gasoline 36.0%, kerosine 51.9%, gas oil and distillate fuel 55.7%, and residual fuel oil 79.5% of normal.

[1]Production—total of gasoline at refineries including natural and blended; kerosine, gas and distillate fuel oil, and residual fuel oil.

[2]Stocks—at refineries, bulk terminals, in transit, and pipe lines of finished and unfinished gasoline; kerosine, gas oil and distillate fuel, and residual fuel oil.

[3]Figures on production and stock include reported totals plus an estimate of unreported amounts and are therefore on a Bureau of Mines basis.

5,000 BARRELS OF OIL FUEL SAVED

DISCOVERIES of new oil fields have not kept pace with consumption . . . and consumption is increasing.

In the face of this situation, the greater efficiency of oil refining and oil burning equipment becomes of paramount importance.

Since 1920, when Foster Wheeler designed and constructed the first successful tubular heater, it has pioneered in increasing design efficiency and construction excellence. Over 1000 units have been built and much progress made.

Heat duty of the unit pictured is 109,000,000 Btu per hour. Furnace efficiency exceeds the contract guarantee . . . fuel consumption per year is 5,000 bbls. less than specified.

Conservative engineering and long experience assure performance such as this and high return upon the investment.

FOSTER WHEELER CORPORATION • 165 BROADWAY • NEW YORK 6, NEW YORK

FOSTER FW WHEELER

MAJOR *Oil Field* ACTIVITIES

▶ **Florida.** The first oil well in this state was brought in by Humble Oil and Refining Company in Collier County, northwest of Miami. Production was found at 11,700 ft. The thick 20 degree gravity oil is now produced by pumping and final outcome is not assured. Importance of the No. 1 Gulf Coast Realties Company well is its evidence of the possible extension of the rich Gulf Coast oil-producing region eastward through Alabama.

▶ **Louisiana.** Sugarfield Oil Company opened a new coastal oil field in the Rosedale area of Iverville Parish, with No. 1 Iverville Mortgage and Loan Company. As it cleaned out the well flowed about 200 bbl. a day through 7/64-in. choke from 10,009-12 ft. The wildcat was drilled originally to 10,025 ft. in 1939 and abandoned by Humble Oil and Refining Company.

▶ **Oklahoma.** A good pool opener in southern Pottawatomie County is the Watchorn Oil and Gas Company No. 1 Sorrell, a wildcat in NWC SE of 20-6n-3e, west of West Asher pool. Production from the Viola Lime at 4130-40 ft. is more than 100 bbl. an hr.

▶ **New Mexico.** After swabbing for an estimated production of 40 bbl., Skelly Oil Company No. 1-U State, new discovery in west central Lea County, has been shot. This operation, in NE of 5-22-35e, plugged back to 4138 ft. to shut off water after drilling to 4183 ft.

▶ **Nebraska.** A possible new oil field has been discovered a mile south of Bellwood. Drillers struck oil on the Pete Nicholas farm, NW of 29-16n-2e, when they broke through cap rock at 1503 ft. and hit the lower Hunton limestone. Discovery wells at Falls City, the only proved Nebraska field so far, were in the Hunton formation. Owners of the Bellwood well are C. M. Turner, J. C. Nicolas, and Robert Wilson.

▶ **Oklahoma.** Mid-Continent Petroleum Corporation No. 1 Edgar Harris, NE SE SW of 29-10-3w, Cleveland County, important Wilcox sand discovery well, has been in difficulty almost since it was reported good for approximately 10,000 bbl. daily. Drilled to 8792 ft. in the Second Wilcox, the hole was lost when the cement plug was drilled. It is considered the outstanding discovery of several years.

▶ **Kansas.** Phillips Petroleum Company No. 1 Volkland, NE NE SW of 27-19-9w, is a discovery well in Rice County. It was completed for 2364 bbl. of oil daily from the Arbuckle at 3234-75 ft.

▶ **Kentucky.** M. P. Evans and associates No. 1 Boswell, 14-0-18, in Union County, 3 miles northwest of the Spring Grove pool, has been named the discovery well of the Raleigh pool. It is 127-bbl. producer from Aux Vases sand.

▶ **Illinois.** After lengthy testing Nash Redwine and Sohio Producing Company No. 1 Taylor, SE SW NW of 21-5s-5e, is near completion as a Cypress sand discovery well for Franklin County. The well made 300 bbl. of oil in 17 hr.

▶ **Kansas.** Morton and Adair et al have completed the No. 1 Joseph Paden, a new McPherson County pool opener, in CWL SW SE of 10-18-1w, for 548 bbl. of oil daily from the chat at 2750-70 ft. The well was treated with 2000 gal. of acid.

▶ **Texas.** King County has a new field discovered by the Humble Oil and Refining Company No. 1 Bateman Estate, section 101, block A, J. B. Rector survey. It flowed 361 bbl. in an official 24-hr. test of a lime at 3688-3703 ft.

▶ **Kansas.** Apparent pool opener in NW SW of 6-17-1e, Marion County, is the Nelson Drilling Company No. 1 Senska. Prospects are for a good well from chat at 2685 ft. Oil stands 2000 ft. in the hole.

▶ **Texas.** Promise of a good pool opener was made by the Arkansas Fuel Oil Company No. 1 E. Lyons wildcat, 2 miles south of Runge in Karnes County. It tested 425 ft. of 38 gravity oil on drillstem test in the Wilcox sand at 6602-07 ft.

AVERAGE CRUDE OIL PRICES

California	
Kettleman Hills	$1.23-1.29
Playa Del Rey	.80- .87
Coalinga	.73-1.13
Wilmington	.68-1.24
Montana	1.00-1.15
Wyoming	.45-1.15
Colorado	1.05-1.07
New Mexico	.70-1.15
Texas	
North Central	.97-1.25
Panhandle	.70-1.12
West Texas	.80-1.27
Gulf Coast	.93-1.48
Darst Creek	1.14
East Texas	.80-1.27
Talco	.79
Kansas	.93-1.25
Oklahoma	.75-1.25
Arkansas	.94-1.36
Louisiana	
Rodessa	$ .88-1.20
Gulf Coast	.93-1.36
North Louisiana	.98-1.80
Illinois	1.22-1.87
Kentucky	1.32-1.43
Indiana	.85-1.25
Ohio	
Lima	1.50-1.60
Michigan	1.24-1.44
Pennsylvania	
Bradford	3.00
Southwest	2.65
Eureka	2.59
Buckeye	2.30
Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

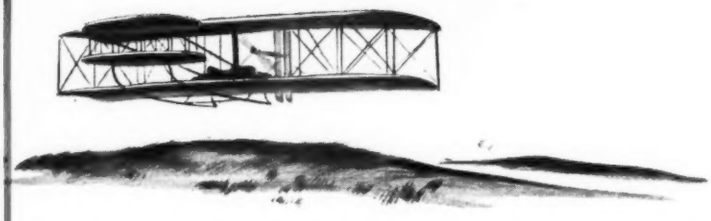
	[1]P.A.W. Recommendations October	ACTUAL PRODUCTION Week Ended Oct. 30, 1943	Week Ended Sept. 25, 1943	Week Ended Oct. 31, 1942
Oklahoma	318,000	[2]329,400	325,250	368,050
Kansas	294,300	[2]274,650	296,150	297,700
Nebraska	1,800	[2] 1,700	1,800	3,450
Panhandle Texas		88,100	104,000	98,500
North Texas		138,300	140,600	140,000
West Texas		354,050	333,500	214,000
East Central Texas		135,250	131,200	90,200
East Texas		368,700	380,000	362,000
Southwest Texas		288,150	263,550	167,700
Coastal Texas		519,350	485,300	321,000
TOTAL TEXAS	1,871,300	1,891,900	1,838,150	1,393,400
North Louisiana		79,600	81,500	98,150
Coastal Louisiana		279,000	278,500	231,000
TOTAL LA.	352,700	358,600	360,000	329,150
Arkansas	77,000	78,950	76,300	73,350
Mississippi	50,000	46,450	48,850	69,200
Illinois	207,500	214,550	215,450	263,600
Indiana	13,800	13,300	14,400	15,900
Eastern (Not incl. Ill., Ind., Ky.)	79,500	76,900	75,200	86,750
Kentucky	24,000	25,500	24,650	11,200
Michigan	59,000	51,800	56,400	60,200
Wyoming	97,000	97,750	102,950	89,750
Montana	23,000	21,350	21,750	21,850
Colorado	7,000	7,100	7,050	7,000
New Mexico	111,000	112,550	109,350	99,500
TOTAL EAST OF CALIF.	3,586,900	3,602,450	3,573,700	3,190,050
California	786,000	780,500	770,700	711,100
TOTAL U. S.	4,372,900	4,382,950	4,344,400	3,901,150

[1]P.A.W. recommendations and state allowables, as shown above, represent the production of crude oil only, and do not include amounts of condensate and natural gas derivatives to be produced.

[2]Oklahoma, Kansas, Nebraska figures are for week ended 7:00 a. m., October 28, 1943.

ONLY EXPERIENCE

fosters special skill



Specialized skill and knowledge obtained through years of pioneering experience are the unseen assets determining the success of any technical service. Oil Well Chemical Service is no exception to this rule.

Dowell is a pioneer in oil and gas well chemistry. It has had more than a decade of oil field experience. Back of its carefully engineered equipment stands a wealth of skill and knowledge gained by treating many thousands of wells.

Contributing to further advancements in this field is Dowell's parent organization, The Dow Chemical Company. Dow's nationwide facilities and expert scientific knowledge assist Dowell in solving oil production problems.

Dowell's pioneering experience has secured an international reputation for dependability and success.

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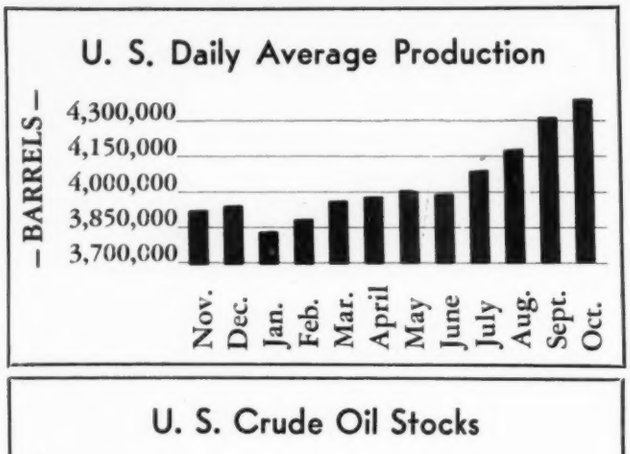
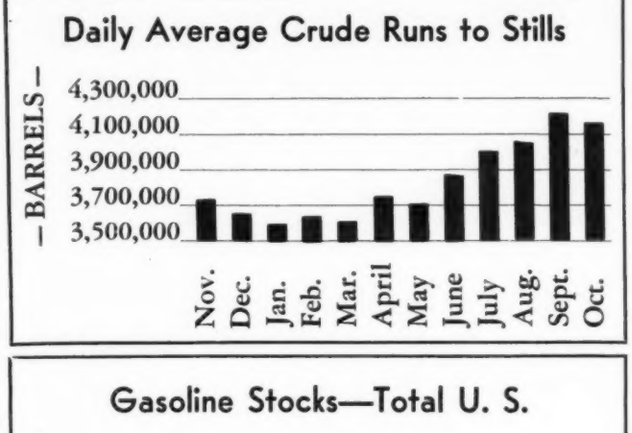
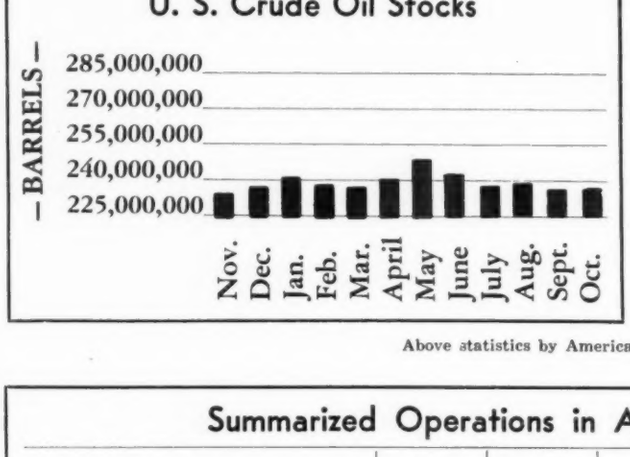
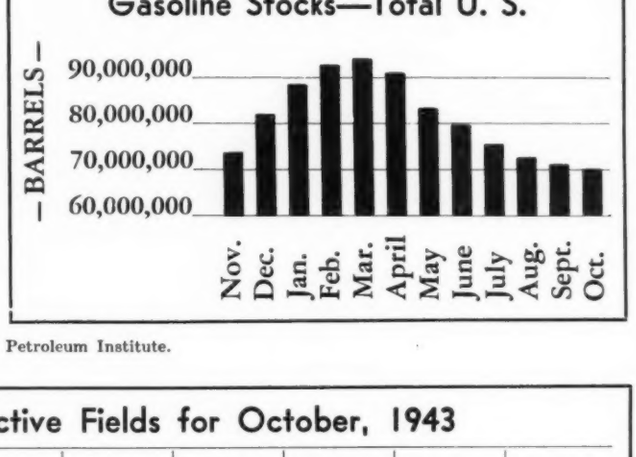
Look to
DOWELL
FOR OIL AND GAS WELL CHEMICAL SERVICE

PETROLEUM *Statistics* AND FIELD *Operations*









Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for October, 1943

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
Eastern Texas	22	13	14	....	3500-3700	2	40	Rotary
Gaines County	2	2	3	....	4400-5584	2	22-35	Rotary
Hockley County	12	11	7	....	4800-6850	2	20-30	Rotary
Ector County	20	18	8	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	16	14	7	....	1700-3900	2	40	Rot.-Cab.
Nueces County	9	8	6	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	18	15	10	....	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	14	12	12	....	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	6	5	6	....	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	12	10	8	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	7	5	6	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	4	4	5	....	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	136	118	82	91	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County			5	....	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	24	18	17	4	1840-11,450	2 or 4	14-30	Rotary
Wilmington County	2	2	1	1	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for October, 1943

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1942 (In barrels)
	October	September	October	September	October	September	October	September	October	September	
Arkansas	14	18	11	16	17	12	8	10	14	18	26,560,000
California	77	85	69	76	61	46	31	28	22	24	248,250,000
Illinois	136	122	118	106	72	51	82	47	91	68	105,768,000
Indiana	40	42	35	33	30	13	4	3	10	6	6,680,000
Kansas	176	172	137	114	45	40	20	20	11	11	96,920,000
Kentucky	58	64	37	43	15	23	....	....	....	....	4,503,000
Louisiana	41	48	32	37	20	31	8	8	18	18	125,450,000
Michigan	47	53	39	45	22	29	11	12	14	....	21,568,000
Mississippi	4	3	1	....	....	....	....	....	....	....	27,605,000
Montana	11	20	7	14	....	....	4	....	....	....	8,998,000
Nebraska	....	3	....	2	4	2	....	....	....	....	1,367,000
New Mexico	18	16	16	12	10	21	....	....	....	....	31,875,000
New York	91*	106*	86*	88*	47	66	22	....	....	....	5,132,000
Ohio	65	73	51	67	31	39	18	....	....	....	3,480,000
Oklahoma	112	107	91	91	42	31	16	18	46	45	138,750,000
Pennsylvania	210*	187*	184*	167*	160	127	....	....	....	....	17,256,000
Texas	318	312	278	253	302	311	241	286	296	205	476,560,000
West Virginia	62	68	54	51	22	20	3	5	15	7	3,780,000
Wyoming	8	14	6	7	5	3	2	2	13	4	32,778,000
Total	1488	1513	1252	1222	905	819	470	439	550	406	1,383,280,000

*Includes water-intake and pressure wells.

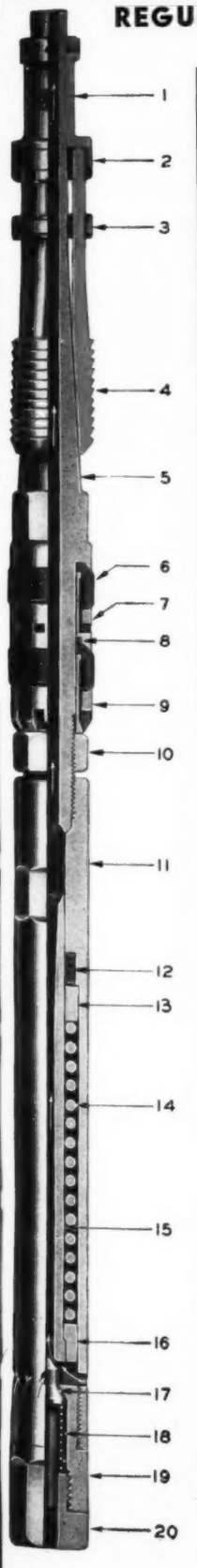
OTIS PRESSURE CONTROL SERVICE - EQUIPMENT

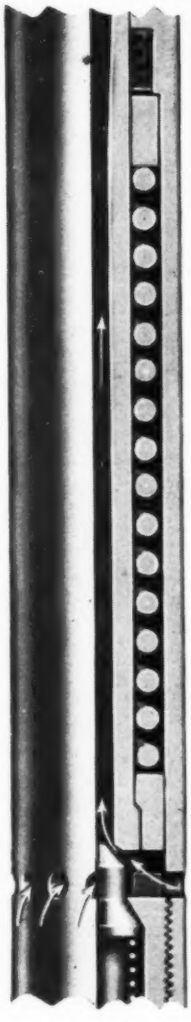
Sub-Surface Facts

OTIS PRESSURE CONTROL SERVICE - EQUIPMENT

No. 4 | 1943 | DALLAS, TEXAS

REMOVABLE BOTTOM HOLE REGULATOR





Section Showing Adjusting Ring and Regulating Spring

PARTS LIST

1. *Slip Carrier*
2. *Slip Carrier Band*
3. *Mandrel Band*
4. *Slips*
5. *Mandrel*
6. *Otis Sealing Cup*
7. *Upper Sealing Cup Ring*
8. *Cup Ring Packing*
9. *Lower Sealing Cup Ring*
10. *Cup Nut*
11. *Valve Cage*
12. *Chevron Packing*
13. *Adjusting Ring*
14. *Regulating Spring*
15. *Valve Seat*
16. *Valve Seat Guide*
17. *Valve*
18. *Valve Spring*
19. *Valve Housing*
20. *Valve Housing Plug*

STOP SURFACE FREEZING WITH AN OTIS REMOVABLE BOTTOM HOLE REGULATOR

RATE OF PRODUCTION CONTROLLED FROM SURFACE

Adjusted to Desired Pressure Differential Before Installation

The Bottom Hole Regulator simply adds the **surface-controlled rate of production** to the advantages of **bottom hole choking.** The opening through the regulator **automatically** changes when the size of the surface choke is varied to allow for increase or decrease in rate of flow. The regulator is, in effect, simply a pressure operated variable bottom hole choke.

Tubing flowing pressures are at all times reduced by a predetermined amount, placing them within a **safe workable limit.**

As indicated in the illustration, a movable valve seat is urged against a valve by a heavy coiled expanding spring. Well pressure acting against the area of the movable valve seat raises it to permit flow up through the orifice in the valve seat. As a result, the flowing pressure above the valve seat is always less than the pressure beneath it by the amount of effective compression per square inch introduced into the spring. The compression placed in the spring is controlled by the thickness of the regulating washer used.

The amount of possible variation in rate of production through the regulator is that amount which the well, after having its flowing pressure so reduced, is capable of producing against line or separator pressure. This possible range in rate of production, after flowing pressures have been reduced to a safe, non-freezing point, is in some instances as high as 9,000,000 cubic feet per day.

TUBING ACTS AS A "MILE LONG HEATER"

The taking of the principal pressure drop through an Otis Removable Bottom Hole Regulator set at several thousand feet below the surface, allows natural formation heat to absorb all resulting temperature losses. The tubing string becomes a "mile long" heater—the most practical and reliable known. This "mile long" heater, unlike surface heaters, does not require constant attention and adjustment.

To withstand the abrasive action of flow through the regulator, heat-treated K-Monel valves and seats with Kennametal inserts are used. This combination of metals has been found to be the most resistant to flow-cutting of all metals tried to date, and has proved very satisfactory, even in high velocity wells that produce sand. Other parts of the regulator are made of regular Monel and stainless steel, to eliminate the corrosive action of sour crudes.

REGULATOR CAN BE RUN OR PULLED ON AN ORDINARY STEEL MEASURING LINE...

The Otis Bottom Hole Regulator is run or pulled under pressure on an ordinary steel measuring line without disturbing the tubing or well pressure. Otis service crews, trained and skilled in the installation of all Otis sub-surface tools, are available in most high pressure areas.

OTIS PRESSURE CONTROL, INC.
DALLAS, TEXAS

MAJOR *Pipe Line* ACTIVITIES

THE last of the contracts for constructing the pipe line from Sundown, Texas, to Drumright, Oklahoma, the river crossings, has been given to O. C. Whitaker Company of Fort Worth, Texas, it was announced by the Stanolind Pipe Line Company, builders. Stanolind has opened an office at Altus for R. H. Dodson, who has been named superintendent of the new division. He will direct work on the 16-in. carrier, which will move West Texas crude oil to Mid-Continent refineries.

A 35-mile loop has been added to the 4500-mile pipe line network of the Lone Star Gas Company, Texas. It extends from the Cayuga gas field in Anderson County to a gate 9½ miles east of Alma, Ellis County. This line, said Julian L. Foster, general superintendent and chief engineer of the company, ties in with a previously laid 37-mile line running from a junction point southeast of Dallas and gives the network a 72-mile conduit from the junction to Cayuga and other gas fields in the East Texas central area. This line parallels the company's 20-in., 117-mile line that extends from Irving to fields in the eastern part of the state. Completion of the new addition assures an increase of 6.5 percent of natural gas for the entire system. Pipe for the loop was reclaimed and relaid by Sharman and Allen, Houston, Texas.

Orders granting the United Gas Pipe Line Company of Shreveport, Louisiana, a certificate of public convenience and necessity were issued by the Federal Power Commission, authorizing the firm to construct and operate additional facilities in Terrebonne Parish, Louisiana, in order to meet the greatly increased demands for natural gas in the Mobile and New Orleans Gulf Coast areas.

United was also authorized to remove certain unused pipe line facilities from the Waskom area in Harrison County, Texas, for use in other parts of the system. The company will remove approximately eight miles of 12¾-in. pipe, leaving part of the line to transport the available supplies of gas in the Waskom area.

The order covering construction of additional lines in Terrebonne Parish is conditioned upon the company supplying to the FPC not later than February 13, 1944, evidence showing that an adequate supply of gas in the South Houma field has been obtained for meeting the demands that may result from the extension of the system.

An 82½-mile oil pipe line will be built from the Elk basin and Frannie fields, in southern Montana, to refineries in Laurel and Billings, it has been announced by the Petroleum Administration for War.

The pipe line, with a capacity of 15,000 bbl. of crude oil daily, will be financed by the Yale Oil Pipe Line Company of Denver, Colorado. It will cost approximately $830,000. The construction schedule and completion date will not be determined until contract negotiations are completed.

The routing of the line is: 6-in. line from Elk Basin field northeast 12 miles to a junction with a 6-in. lateral line 3½ miles long from the Frannie field; thence an 8-in. line north for 45 miles at which point the main line will feed into two 6-in. laterals, one going 10 miles to Billings and the other 12 miles to Laurel.

J. E. Douglas of Harris County, Texas, has applied for a permit to lay a pipe line from the Mercedes field in Hidalgo County to the new Willamar field in southwestern Willacy County. It is proposed to pipe gas to the field for fuel.

The Southwest Emergency Pipe Line, a Defense Plant Corporation project, began operations with a delivery of 50,000 bbl. of oil daily. It will have a capacity of 75,000 bbl. when all stations are in operation. The 150-mile line extends from Refugio, 35 miles north of Corpus Christi, Texas, to Houston. It was converted to the transportation of oil by reconditioning a 14-in. and 16-in. gas line. The line was completely reconditioned by being removed from the ground, cleaned, repaired, and welded to withstand pressures as high as 550 lb.

The Atlantic Refining Company, Barnsdall Oil Company, Humble Oil and Refining Company, and The Texas Company reversed their movements in the Corpus Christi area in order to deliver oil from there to the initial station at Refugio. The operation of the line will feed crude oil into the reversed Pan American and Shell lines, which in turn will deliver the oil into the 24-in., or Big Inch, pipe line at Longview, Texas. Previously, oil from the southwest Texas fields had to be moved from Corpus Christi to Houston by shuttle boats, and thence to Longview by the two reversed pipe lines.

Construction on the 250-mile, 8-in. Sinclair products line from East Chicago, Illinois, to Toledo, Ohio, is nearing completion and is expected to go into operation in December. The line will have a capacity of 30,000 bbl. daily. At Toledo the products will be shipped eastward by lake tanker when the water is navigable. The products will also be used to maintain inventories in nearby midwestern cities.

The A. O. Smith Corporation of Milwaukee, Wisconsin, has received an order for 900 miles of 24-in. welded pipe for the new gas line to be built by the Tennessee Gas and Transmission Company of Houston, Texas. The order is for approximately $10,000,000 and calls for 150,669 tons of 24-in. welded pipe of ¼-in. wall thickness.

The carrier is to be built from Corpus Christi, Texas, to Charleston, West Virginia, a distance of 1188 miles, and will serve war industries of the Appalachian area.

Opposition to the lines from various groups has not halted progress on the project. Several Texas state officials have stated definite objections to taking gas from Texas to an area where coal is plentiful. Gov. Coke Stevenson suggested that a heavy severance tax should be imposed by Texas on all natural gas shipped beyond the borders of the state. A letter to the governor from Richard Wagner, president of The Chicago Corporation, which owns the Tennessee firm, stated these possible effects of the export line: A stiffening of the price of Gulf Coast natural gas; larger returns to land and royalty owners; increased tax collections for the state, and a greater conservation and recovery of gas now being wasted.

Both the War Production Board and the Federal Power Commission authorized the line on condition. The WPB stipulated that the line should be in operation by the fall of 1944, which was also inserted in the FPC's certificate. The FPC also made its certificate contingent upon approval of plans made by the Tennessee Gas and Transmission Company for financing the line. The Chicago Corporation has since bought control of the firm.

Pipe for the 335-mile, 12-in. pipe line of Magnolia Petroleum Company from Midland to Corsicana, Texas, has begun rolling from the mills. With a capacity of 42,000 bbl. daily, the line will provide another outlet for oil from the West Texas fields. The line is scheduled to be in operation in March, 1944. Feeder loops are already under construction with second-hand pipe used but work has been slowed by labor shortage.

P 501.61.

THE Petroleum Engineer

NOVEMBER, 1943

Disposal of Salt Water In the East Texas Field

☆ Methods in use are solving a vital problem in world's largest oil field

by L. H. Dial

Chief Engineer
East Texas Salt Water Disposal Company

RECOGNITION of the East Texas field as a water drive field came early in its development and operators agreed that ultimately large quantities of salt water would be produced with the oil from the Woodbine sand. Maintenance of reservoir pressure in an active water drive field is possible if the withdrawal of fluid from the sand is equal to the rate of water encroachment. Numerous engineers, considered authorities on the subject by the industry, have estimated a safe withdrawal rate of from 625,000 to 650,000 bbl. per day. Production of the East Texas field today by permission of the Texas Railroad Commission is 383,000 bbl. of oil on a calendar day basis. In order to produce this volume of oil, the field produces about 365,000 bbl. of salt water per day. To reduce the net withdrawal and at the same time prevent curtailing oil production, it was considered sound engineering practice to inject the salt water back into the Woodbine sand in the water encroaching area of the field. Successful organization of a field-wide salt water injection program required the full cooperation of all the operators in the field.

It had become evident, even to persons not directly interested in producing the oil, that salt water produced in the field and disposed of by turning it into streams and ponds, was polluting streams and rivers, so contaminating it that it was unsuitable for industrial and agricultural purposes. For example, the City of Beaumont's water supply was made unsatisfactory due to the salt water from the East Texas field.

L. H. DIAL

was graduated from Georgia Tech in 1930 with a B.S. degree in electrical engineering—Joined the staff of the Stanolind Oil and Gas Company in April, 1933, and beginning in 1935 handled Stanolind's salt water disposal problems in all fields until November 1, 1942, when he joined the staff of the East Texas Salt Water Disposal Company—He is chief engineer of the company.

Organization of the East Texas Salt Water Disposal Company resulted from these needs and is accomplishing very successfully its dual purpose: To maintain underground reservoir pressure to permit maximum withdrawal of the oil and to prevent pollution of surface drainage.

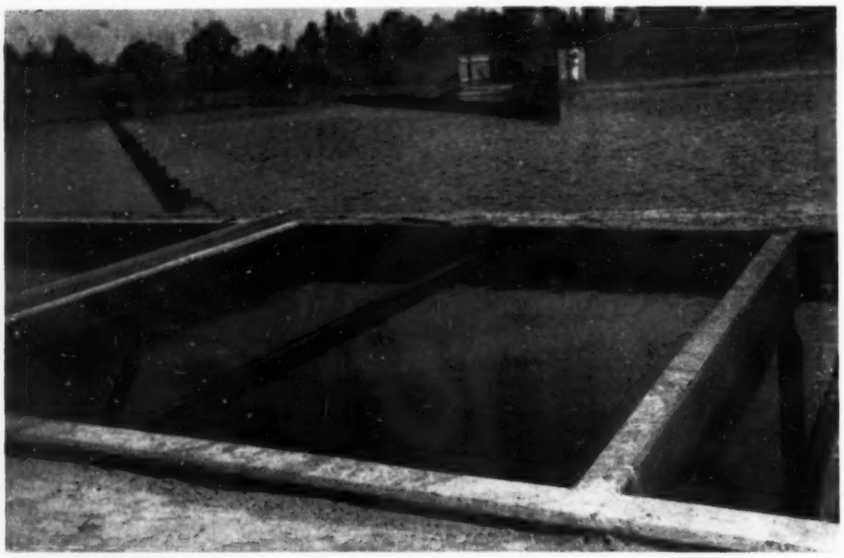
Salt water disposal technology, as practiced by the East Texas Salt Water Disposal Company, requires use of numerous branches of engineering including chemical, mechanical, metallurgical, electrical, civil, and petroleum. The company is fully staffed with competent and experienced engineers, who by constant study of the problems confronting them have greatly improved all phases of the salt water injection operation. Of the 61 salt water disposal wells, drilled or converted, 22 are operated by the East Texas Salt Water Disposal Company. The remaining 39 are operated by various oil companies.

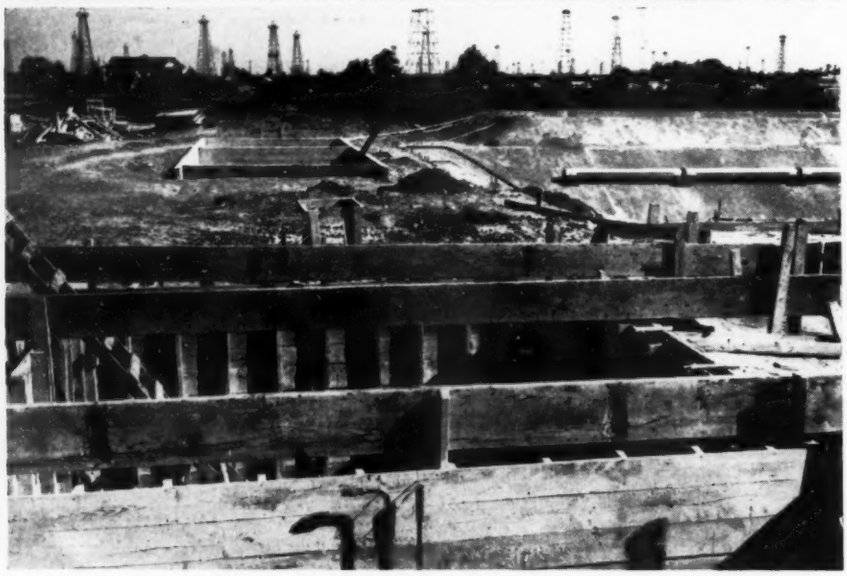
Collection and Disposal

A network of pipe lines takes the

salt water from the leases, where it is produced, and collects it at central treating plants. Small amounts of oil in the water are removed by flowing the water through one or more skimming basins. Separation of the oil from the water is important as any precipitate subsequently forming in the salt water will have a film of oil around it that will prevent the solid particle from settling out of the water.

Separated from the oil the water is thoroughly aerated by one of two methods: Passing it over a roughened concrete slab in a thin sheet or through a spray tower. The aeration causes the iron in solution to oxidize, forming a finely divided iron oxide that gives the water a red, muddy appearance. Alum fed into the water by constant feed and proportioning devices speeds precipitation of the finely divided iron oxide particles. Lime is occasionally used to control the pH of the water and to reduce the supersaturation of calcium carbonates. This treatment of the water is regarded as the stabilizing treatment.





A large number of algae and bacteria are found in the water so that sterilization is equally as important as stabilization. The bacteria and algae, if permitted to grow, would multiply and form jelly-like masses that would cause plugging of the sand in the injection well. Chlorine is used to sterilize the water killing the bacteria and algae. Direct generation of chlorine from the salt water has been found to be very satisfactory and highly desirable from the operational point of view.

Sodium chloride electrolysis is obtained by passing heavy direct current through the water between carbon electrodes. It has been found that between five and six volts are necessary to carry 500 amp. Free oxygen liberated in addition to the chlorine aids aeration of the water. The electrolysis equipment used, of the low voltage high amperage direct current type, depends upon the location of the pit in which the chlorine is to be generated. Unless electric power is available, permitting use of copper oxide rectifiers, gas engine driven generators are used.

Settling Basins

When the treating course has been completed the salt water flows into the main settling basin. The newer pits and tanks are of gunite construction providing low initial cost and simplified and speedy construction. The main settling basin is equipped with over and under baffles and slotted inlet and outlet headers that aid very materially in the sedimentation process. The size of the pits are approximately 70 ft. by 137 ft. by 8 ft. Use of the slotted inlet pipe extending completely across one end of the pit distributes the water evenly and reduces channeling to a minimum. Water bearing solid particles are introduced near the bottom, which aids the clarification process.

Top: Slotted pipes in oil-skimming basins can be adjusted by levers. Center: Motor-driven pump handles water between filters and backwash water storage tanks. Bottom: Collection pit under construction

An over and under baffle is situated about one-third the length of the pit from the inlet. The clearest water moves from the top of the first section and is introduced into the second section near the bottom, aiding the sedimentation process. Other over and under baffles placed about two-thirds the length of the pit cause further sedimentation and clarification of the water. The outlet header, slotted, takes clear water from the pit. This header is higher in the pit than the inlet header and thus removes only the clearer water. Then after the water passes through the pressure sand filters, it is sparkling clear, sterile and ready to be pumped to the disposal well.

Disposal Wells

The disposal well may be regarded as the heart of the salt water disposal system. Although the East Texas Salt Water Disposal Company has used several completion methods for disposal wells, it has now more or less adopted the following procedure:

1. The surface hole is drilled to about 110 ft. Then 10¾ in. casing is set and cemented with 50 sacks of cement.

2. Cement then sets a minimum of 24 hours and a 9⅞ in. hole is drilled to the top of the Woodbine sand. At this point the hole diameter is reduced to 6¼ in. and the hole drilled to the base of the sand.

3. The casing seat is selected after an electric log is run to determine the base of the first shale break below subsea depth of 3320 ft., the original oil-water interface.

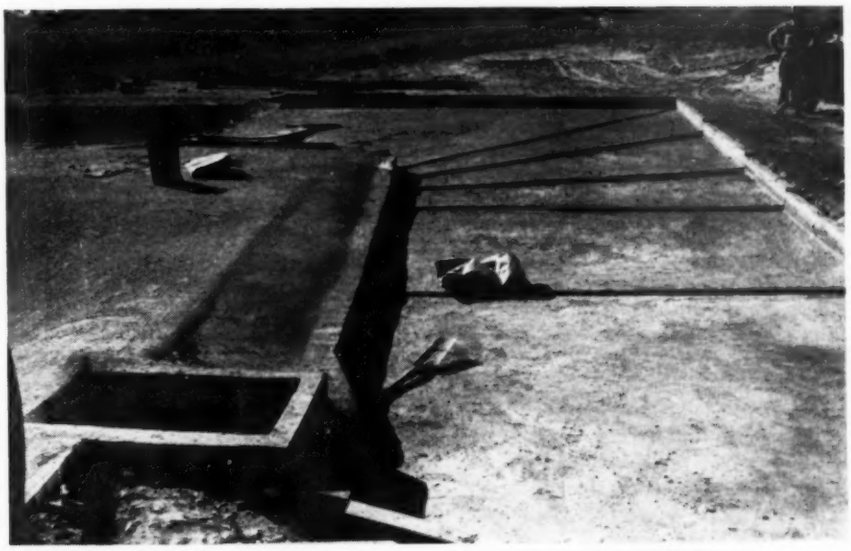
4. Seven-inch casing is then run to the casing seat and cemented with 150 sacks. An official Railroad Commission test is made after the cement is allowed to set a minimum of 48 hours.

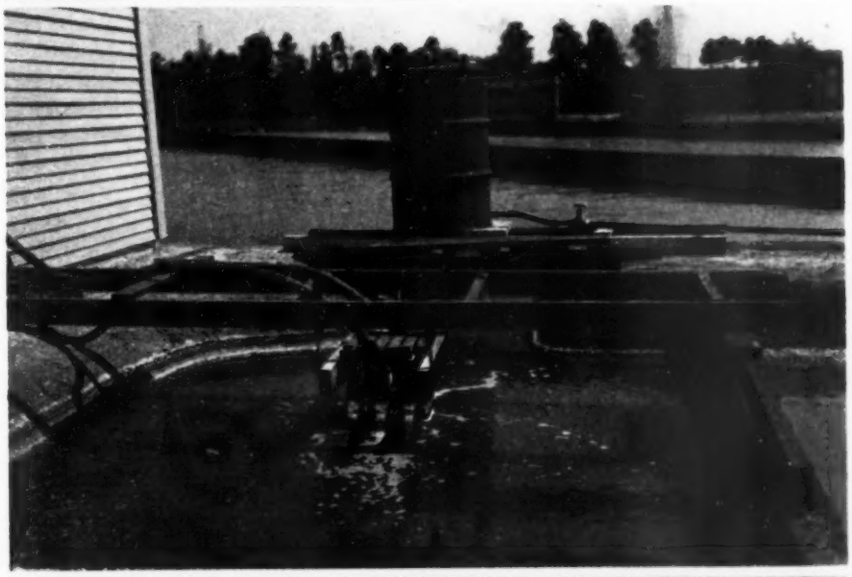
5. After a satisfactory test the plug is drilled and the 6¼ in. hole underreamed from the casing seat to the total depth of the well to 8 in. diameter. Underreaming is done by reverse circulation using gas lift to remove cuttings.

6. The well is then flowed by gas lift until thoroughly cleaned.

7. Cement lined tubing 5½ in. in diameter and equipped with a hookwall packer, is run in the hole and the packer set as near the bottom of the 7 in. casing as is practical and the well completed for the disposal of salt water.

Despite all previous measures the sand in the disposal well will eventually plug up and refuse to take water satisfactorily. Cleaning the well depends on the plugging material; however, in general, a well can be cleaned by backflowing at a high rate with gas lift. This is followed by an acid treatment and a second backflowing. Should this treatment fail to clean the well, it is usually necessary to underream the sand section to remove the plugged portion of the sand face.





Top: Water passes in thin sheet over concrete aerating baffles from oil filters. Center: Chlorine generation by electrolysis of the salt water. Bottom: Over and under baffles being constructed. Note high slotted outlet pipe

Salt water injection well. Collection basin and pressure sand filters in background

The salt water disposal company attempted to maintain wells clean in the early stages of its operations, which permitted the water to flow into the sand by gravity. This practice eliminated the use of injection pumps. Excessive costs soon made it evident that economical operation required the use of an injection pump when the well failed to take sufficient quantities of water by gravity. Although the economical limit of pumping varies considerably, it has been found that when the pump pressure reaches 500 lb. per sq. in. the well requires cleaning.

Equipment Corrosion

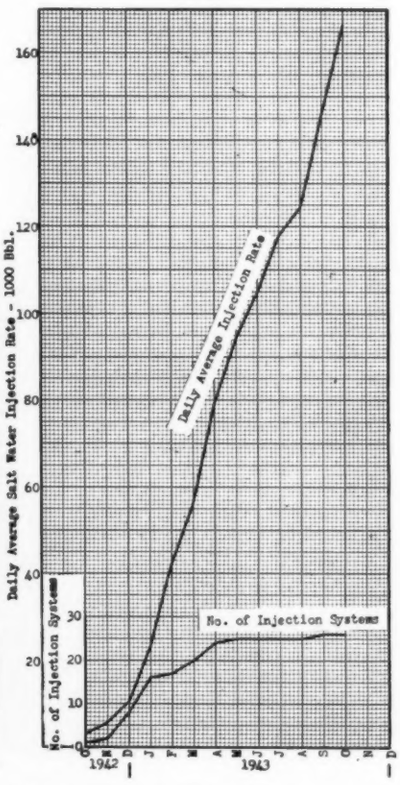
Corrosion of salt water disposal equipment is a never-ending problem. Equipment that comes in contact with the salt water must be designed to resist severe corrosion. This is especially true of pipe lines and pumps. Asbestos cement pipe has been found especially suitable for handling salt water. It is not only unaffected by corrosion, but offers immunity to tuberculation and electrolysis, two forces that have heretofore limited the useful life of pipe. Pipe of wood fiber coal tar manufacture has also been used with success, however, in a limited field of application.

In applications where high pressures are required cement lined steel pipe has been found most satisfactory. The lining of cement in the pipe protects the steel from the salt water, but the outside is attacked by soil corrosion especially if the line is laid in ground impregnated with salt water. Obviously, the pipe has a very limited life under such conditions as compared to either the asbestos cement pipe or the wood fiber coal tar pipe.

Materials for pumps present one of the most troublesome problems in view of the difficulty of obtaining the critical metals required. In reciprocating pumps monel is required for the rods; also the shafts in centrifugal pumps. Pump liners and impellers require nickel-iron alloys. Many substitutions of other materials have failed to produce entirely satisfactory results. The most satisfactory and immediately available pumps are made of all iron and of bronze with no zinc.

Left: Copper oxide rectifiers are used where electric power is available

Right: Progress chart of salt water injection in East Texas field



P 683.32.

Pressure Extension Chart For Orifice Meters

☆ **Chart designed for simple and rapid computation of measurement values**

by William F. Martin

Texoma Natural Gas Company

THERE are still a number of orifice meter charts being computed by the inspection method. The inspection method, in connection with charts having the differential laid off in inches of water and the static in pounds per square inch, entails the use of a voluminous extension table. It occurred to the writer that a chart could be used to replace these extension tables.

Referring to the chart: By drawing a straight line from the intersection of the differential and static pressures to "X", hourly extensions can be read close enough for all practical purposes on the hourly extension scale where the straight line crosses it. When there is not enough variation to make any appreciable difference, the 24-hr. extension can be read on the 24-hr. extension scale.

It is desirable at times to be able to obtain an estimate of the hourly production of a well, and this can be obtained from the chart. It is only necessary to follow the straight line to its intersection with the coefficient line and read production on the vertical line where it crosses the hourly volume scale.

This chart provides a convenient method of obtaining the orifice size for a given production through a given pipe size at given differential and static pressures. For this computation, the straight line from the intersection of the differential and static pressures and "X" is followed down to the vertical line, which represents the hourly production required. At this intersection, follow the horizontal line drawn through the intersection to the right to ascertain orifice size for 4, 6, and 8-in. meter runs. The 10, 100, 1000 and 10,000, which appear in the orifice size section, indicate the number of whole figures in the coefficient.

The following sketches, Figs. 1 and 2, graphically explain the operation of the chart. A full scale drawing of the chart is contained on page 64.

Fig. 1. Example showing use of chart to find coefficient, required volume, and orifice size. Note that a straight line is drawn from the intersection of the static and differential pressures to "X."

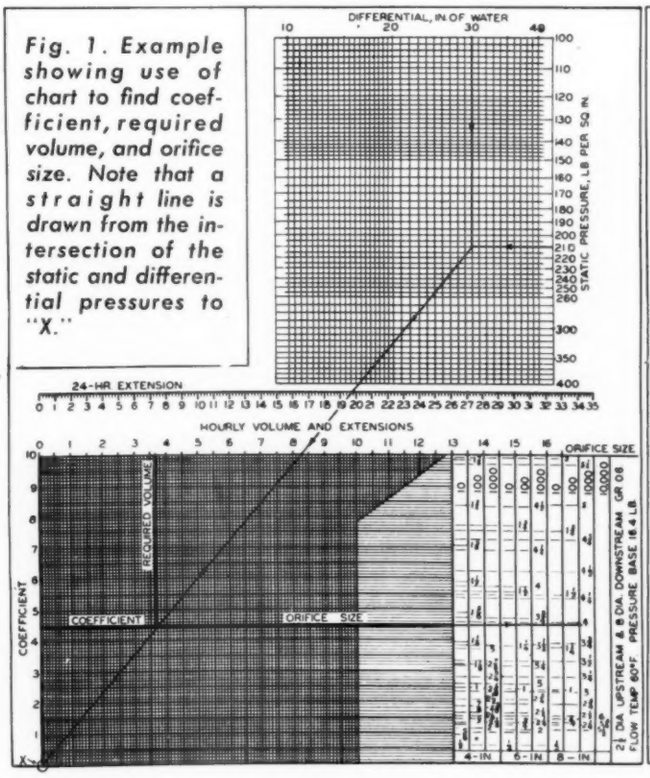
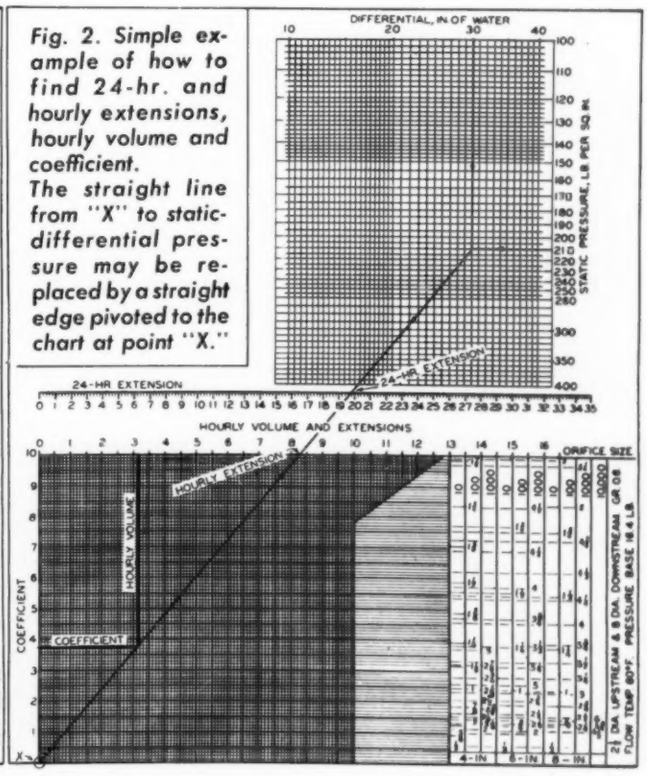
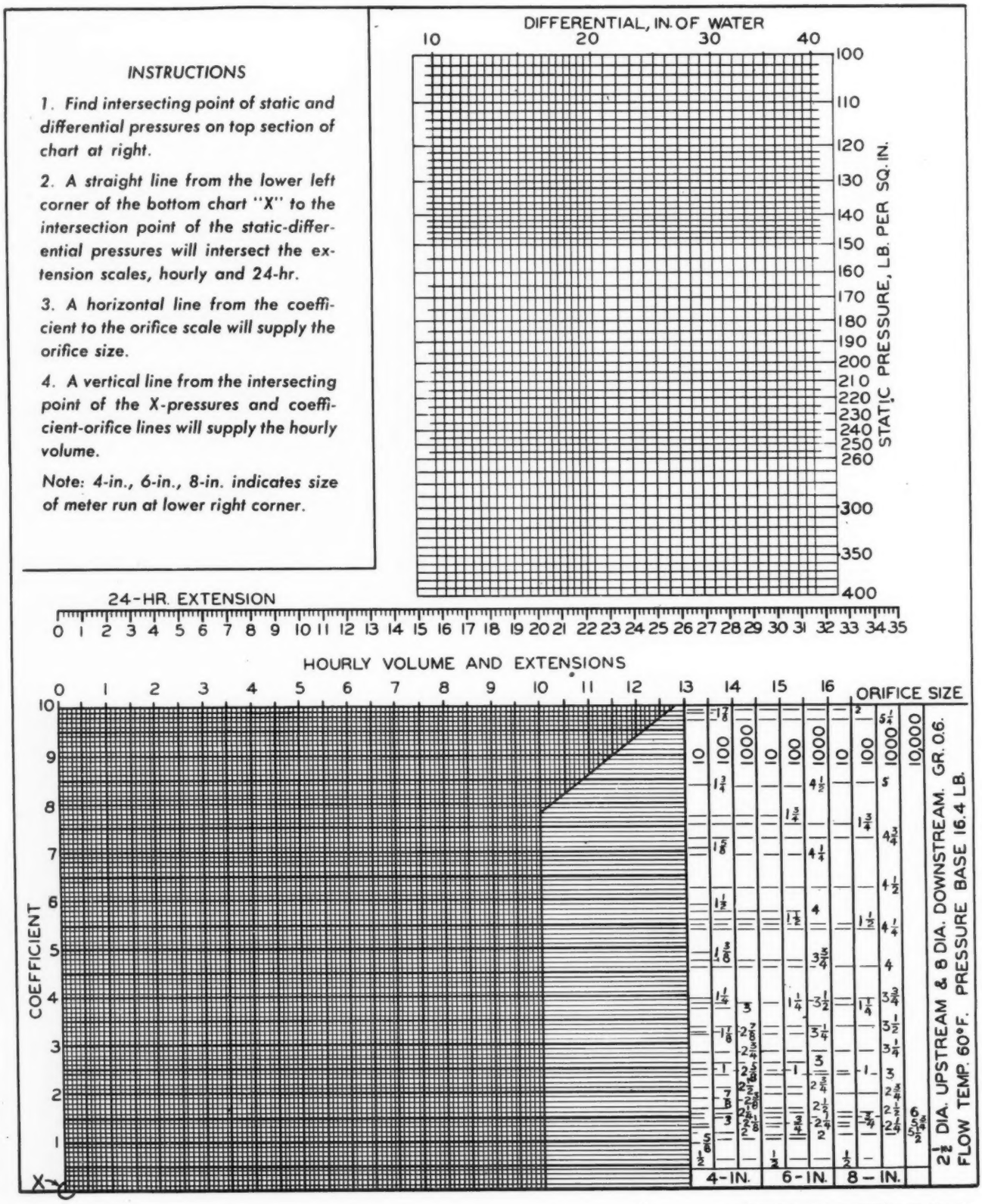


Fig. 2. Simple example of how to find 24-hr. and hourly extensions, hourly volume and coefficient. The straight line from "X" to static-differential pressure may be replaced by a straight edge pivoted to the chart at point "X."



Pressure Extension Chart for Orifice Meters


INSTRUCTIONS
1. Find intersecting point of static and differential pressures on top section of chart at right.
2. A straight line from the lower left corner of the bottom chart "X" to the intersection point of the static-differential pressures will intersect the extension scales, hourly and 24-hr.
3. A horizontal line from the coefficient to the orifice scale will supply the orifice size.
4. A vertical line from the intersecting point of the X-pressures and coefficient-orifice lines will supply the hourly volume.
Note: 4-in., 6-in., 8-in. indicates size of meter run at lower right corner.
DIFFERENTIAL, IN. OF WATER
10 20 30 40
STATIC PRESSURE, LB. PER SQ. IN.
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 300 350 400
24-HR. EXTENSION
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
HOURLY VOLUME AND EXTENSIONS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
COEFFICIENT
10 9 8 7 6 5 4 3 2 1
X
ORIFICE SIZE
4-IN.
6-IN.
8-IN.
2½ DIA. UPSTREAM & 8 DIA. DOWNSTREAM. GR. 0.6.
FLOW TEMP. 60°F. PRESSURE BASE 16.4 LB.

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Caliper Well-Logging

PETROLEUM ENGINEER Exclusive Feature

☆ Important data on hole bore derived from study of caliper runs

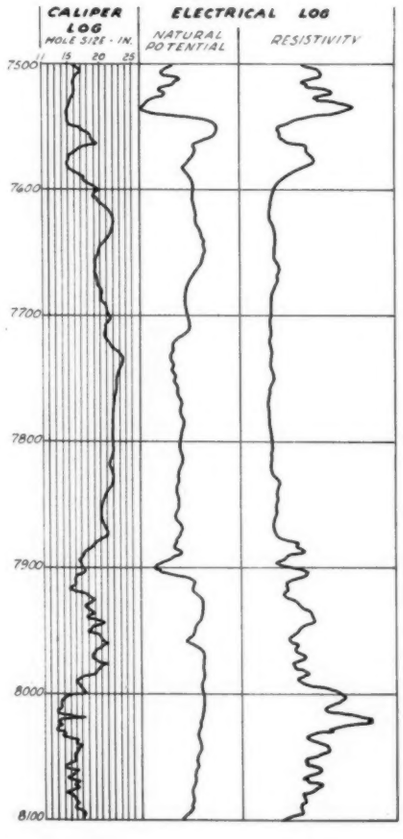
by William H. Farrand

Superintendent Drilling and Production, Pacific Coast Division, The Texas Company

IT HAS long been the belief of everyone connected with the drilling of oil wells that the actual diameter of the hole made by a bit is seldom the same as the gauge of the bit. Fishing tools only a fraction of an inch under hole gauge would pass the fish, indicating oversize hole. This belief has been substantiated by the use of open hole calipers, which have been run in a number of wells during the last few months and which have disclosed conditions that were somewhat unexpected as well as informative. Utilization of the data supplied by caliper logs has been varied but it is natural that the full scope of the adaptability of the equipment has not been realized in the short time it has been available.

The use of calipers to determine the size of hole actually made by the bit was conceived several years ago by Myron M. Kinley, known throughout the world for his fire fighting technique and performance, who developed a mechanical type of caliper. Then, in cooperation with Halliburton Oil Well Cementing Company, joint experimental and development work was done and the present calipers, which combine mechanical and electrical principles, were perfected. These calipers are run into the well on a wire line in a closed position and when they reach the bottom of the hole or the lowest point of the distance through which a caliper survey is to be made, four arms that contact the wall of the hole are released. The calipers are then withdrawn at a rate up to approximately 100 ft. per min. and automatically record the variations in diameter of the hole on a chart at the surface.

Fig. 1



The arms are independent of each other and as each rides over the irregularities of the wall of the hole it indicates by electrical means its varying distances from the center line of the calipers during its upward travel. The movement of the individual arms is measured by electrical resistance and the sum of the resistances of the four arms is automatically divided by four by an instrument at the surface. The average thus resulting is recorded by the instrument in inches to give a continuous reading of the mean diameter of the hole, as shown in accompanying illustrations. Although the shape of the hole is not given, the cross-sectional area is indicated by the mean diameter, which thus shows tight spots as well as enlargements. The maximum diameter measured by calipers now in use is 36 in.

As the arms move individually, errors that would otherwise arise from elliptically shaped holes, from measurements taken in holes at an angle from the vertical, or from other irregularities are eliminated. Extreme irregularities such as key seats may not always be picked up by the calipers but such conditions will probably be rare and the size of hole indicated by the calipers will be very close to actual. Moreover, the slight errors due to irregularities of the wall between contact points of the four arms will probably be compensating.

WILLIAM H. FARRAND

after graduating from Hamilton College in 1922, spent five years with the Standard Oil Company of New Jersey doing field work in Roumania—Returning to the United States he spent the next two years in obtaining an M.S. degree in geology at the University of Southern California—He entered the employ of The Texas Company in 1929 and has been with that company ever since—Is now superintendent of drilling and production, Pacific Coast Division.

Contrary to the expectations of many, logs both in California and in other areas where the calipers have been run show that in general the hole is larger in shale than it is in sand. There are naturally different kinds of shale and different kinds of sand so any relative difference in hole size in shale and sand cannot be expected. The extent to which a hole is enlarged beyond the gauge of the bit will naturally vary with the drilling technique. (See Fig. 1.)

When the caliper log has been taken before cementing, it has usually been found that the volume of slurry that would otherwise have been placed behind the casing was inadequate. In one field where the practice had been to use 700 sacks of cement for a certain string, nearly 2000 sacks were necessary to fill to the point desired. (See Fig. 2.)

Another use of this instrument is to determine whether the hole needs reaming before running pipe. As holes become smaller in diameter there is less clearance around the casing. Long reaming jobs have resulted as drilling fore-

men were reluctant to run pipe with greatly reduced clearance. The hole caliper run overcame this difficulty and if the log of the run was satisfactory no reaming was done. At the most, "spot" reaming of tight hole was sometimes indicated. This lead to much less unnecessary reaming and to the practice of not carrying full sized reamers or stabilizers while drilling. A considerable saving in time and material resulted from this application.

If multiple jobs are to be employed, the caliper again indicates how much or how little cement is necessary to effect the shut-off at points up the hole. In this use it is quite likely that a squeeze job can be saved by an actual determination of the hole diameter at the places where upper hole jobs are to be used either by multiple stage cementing the shut-off string or for future perforating opposite upper productive sand bodies.

After the hole has gone a little too deep and a bottom hole plug is necessary, again a caliper survey shows how much cement is needed to raise the plug to the desired height, and a recement job may be saved by this process.

Fig. 2

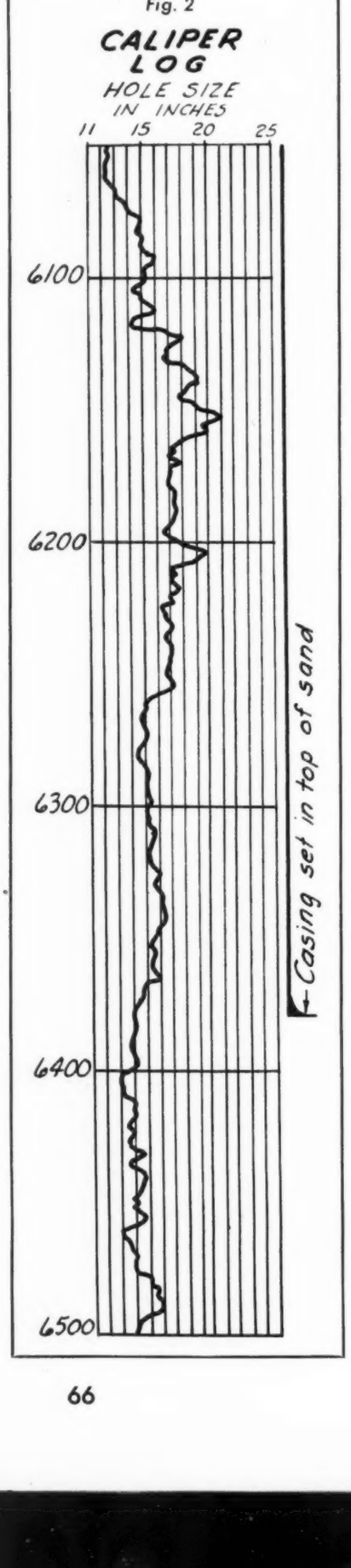
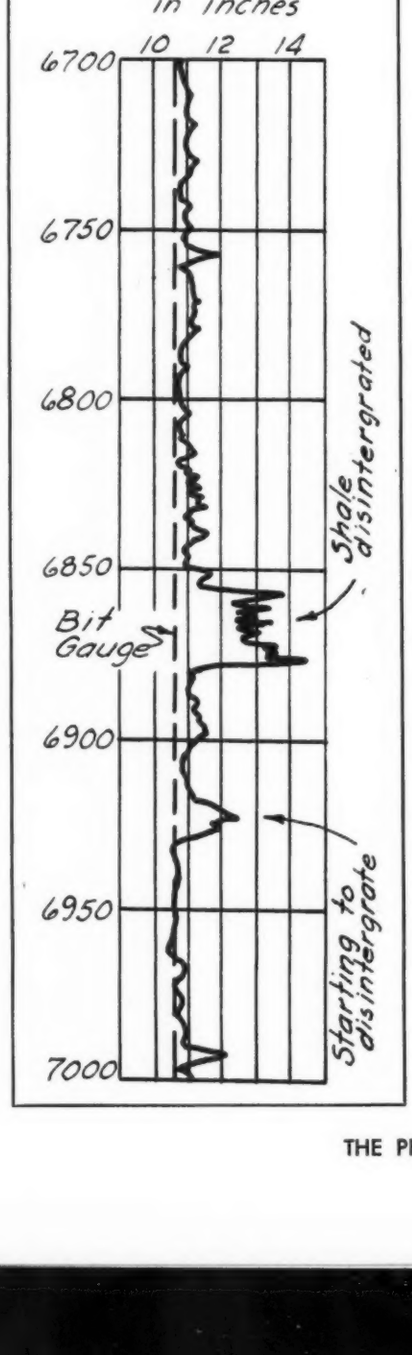


Fig. 3



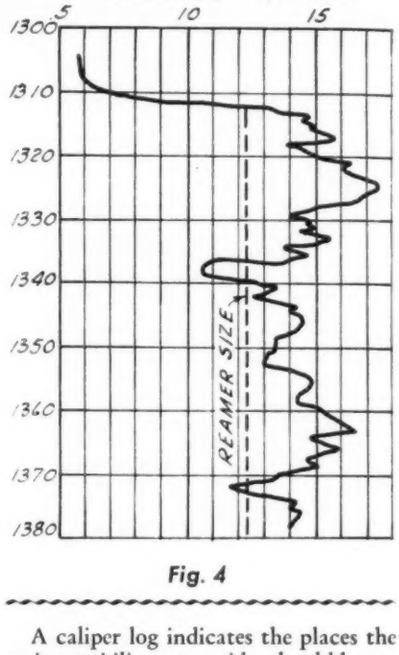


Fig. 4

A caliper log indicates the places the casing stabilizers or guides should be attached to pipe before it is run.

The guides are obviously useless if the spring ribs cannot contact the sides of the hole and thus center the pipe to permit a good collar of cement to surround shoe and lower section of the string.

The same information will indicate where the hole scratchers should be placed to clean the walls for the cement job. Many stabilizers and scratchers have been placed opposite shale bodies when caliper surveys show the hole usually to be enlarged.

Another application is the determination of the cement point by the use of this log, in combination with an electric log of the formations. It is customary in oil field development to set the casing in shale above the sand from which production is expected. The hole caliper logs indicate that this may not be the best procedure, and the shales are usually the places in which oversized bore develops. This explains why sometimes a shoe set in a good shale body is found to have a faulty shutoff. The cement failed to scour the wall at this point and water enters from the overlying sands, with the resulting squeeze job.

Later failure of the shutoff may develop for this same reason. A progressive disintegration of the shale due to the presence of water in the hole may allow water to enter around the cement, which during the shoe test successfully shut off the unwanted fluid. (See Fig. 3.)

Correlations by the use of the caliper log are also possible. As the shales in the holes tend to develop oversized bore, and the sands remain nearer to hole diameter size, the logs when studied give another bit of necessary information

Fig. 5

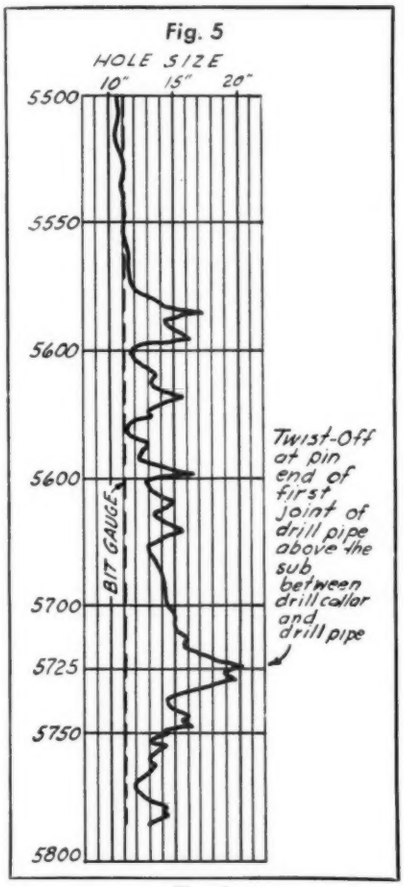
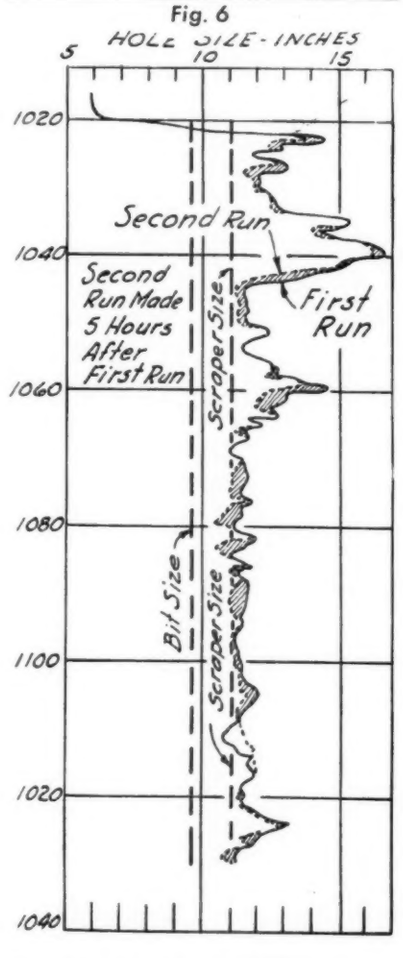


Fig. 6

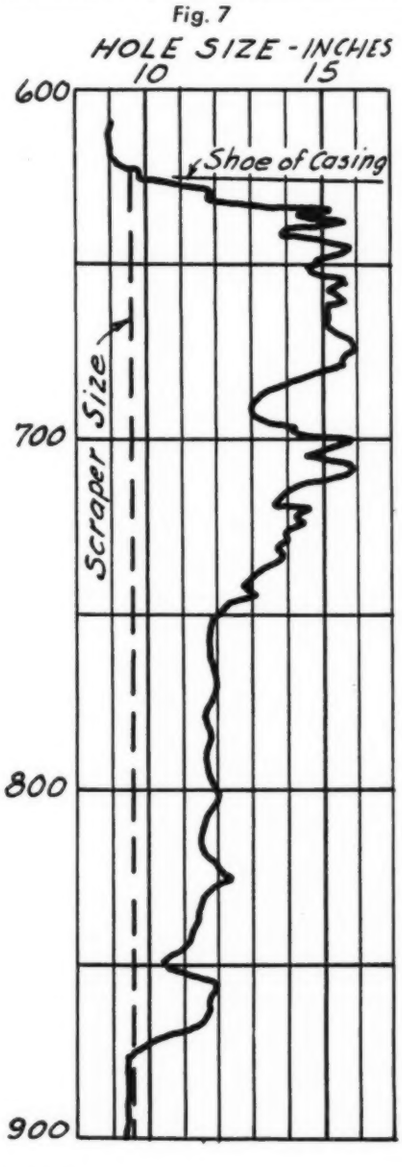


the engineers need to make their correlations more correct. Sandy shales vary and, although they offer similar characteristics in adjacent holes, they are not quite the clear evidence offered by the all sand and shale sections. It has been noted, however, that sections of holes will show the same general character that is found in other holes, and the correlations are thereby affirmed.

Many formation test misruns could have been saved by use of the caliper. The expansion of the rubber on a formation tester is limited and if the hole is oversized at the selected point above a sand to be tested the packer cannot hold and the test is a misrun.

One company ran a caliper after some failures of the tester to hold over a sand in a wildcat well. This caliper run showed oversize hole at the points selected and indicated where the tester could be set successfully. The formation tester was again run—this time it held and the sand was tested.

Fig. 7



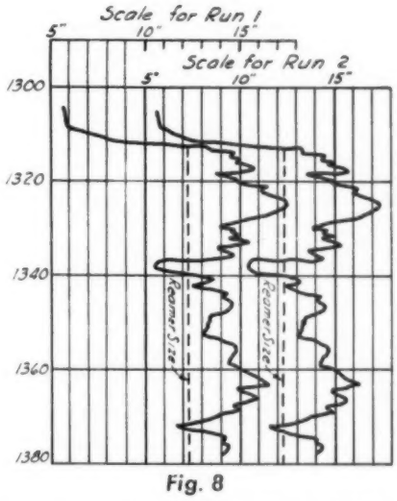


Fig. 8

A more specialized use of the hole caliper is to determine the hole volume for gravel packing. The volume shown by the caliper run may be accepted as a check on the completeness of the job. Formerly the size of the wall scraped or underreamed hole was used, and possibly too little gravel was thus placed behind the liner with the result that some sand trouble developed when the well was placed on production.

Now a run of the caliper should be made after the hole has been wall scraped below the shutoff string. (See Fig. 4.) If the job of scraping is to gauge the liner may be run and a reverse circulation gravel pack job is performed. If the hole is not to gauge—and this is by no means a rare occurrence—the hole is rescraped, another caliper run made, and the job accomplished.

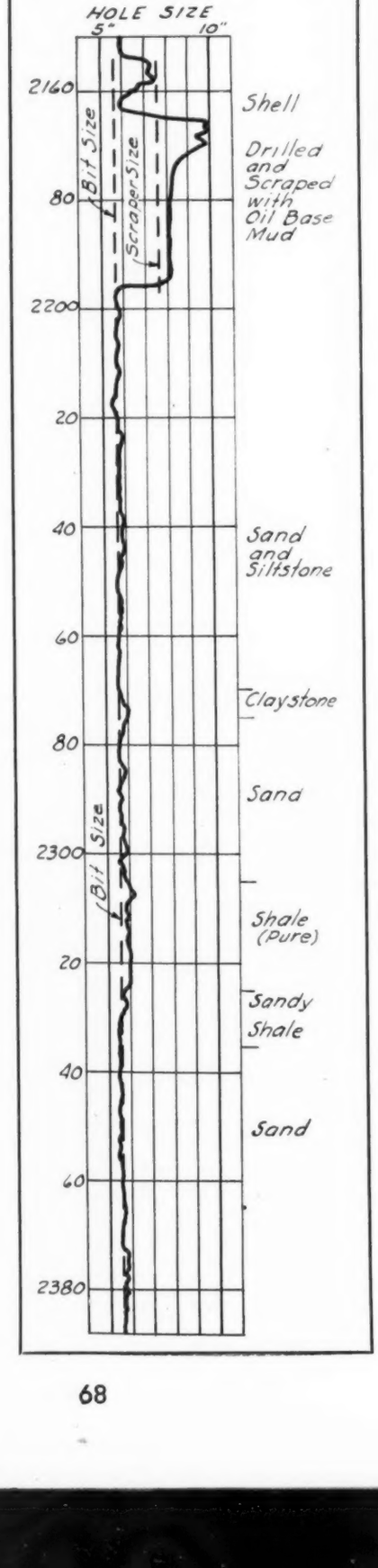
Incidentally, this has been a good test of the caliper accuracy. Many jobs have checked the hole volumes as shown by the caliper run with considerable accuracy, sometimes to within a cubic foot. If the volume of gravel calculated by this method does not check the volume while performing the job within reasonable limits the liner should be pulled out and the job re-done. This infrequent check on the well caliper has led to its accuracy being accepted without question. The one or two occasions when the liner was pulled because of the discrepancy between calculated volume of gravel and the amount put away while doing the gravel pack job have only demonstrated its accuracy. On these occasions considerable cuttings were found in the hole and after removing them the job went off as calculated. This has been eliminated by more thorough circulation after the hole has been scraped to bottom.

Aid to Fishing

Inability to "get over" a fish has long plagued the drilling departments. The hole caliper logs show why this is often

the case. Shale tends to disintegrate while the drilling proceeds and the shale sections of the hole become enlarged. Hence when a twistoff occurs, the hole is composed of sections of large and small diameter. The smaller diameter sections prevent the fishing tool from getting over the fish, particularly if the fish is in one of the enlarged sections of the hole.

Fig. 9



A perfect example of this is shown in Fig. 5. Here the twistoff occurred at a depth of 5725 ft. leaving the top of the twisted off drill pipe and drill collar in the largest portion of the hole. Considerable trouble was encountered in trying to locate the top of the fish although the drill pipe measurements were accurate.

It is very interesting to note that the twistoff occurred in the lower part of the single above the drill collar opposite the enlarged hole. In this particular case only two of the six drill collars were recovered. The caliper run proved useful, however, when it was decided to cement the four collars left in the hole and sidetrack them. Nearly double the volume of cement was necessary to fill

Fig. 10

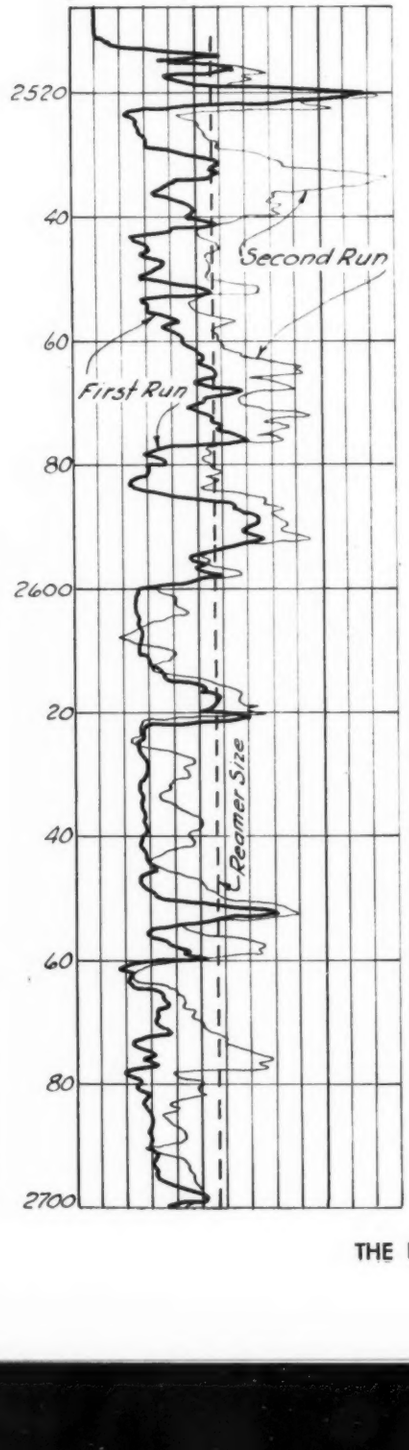
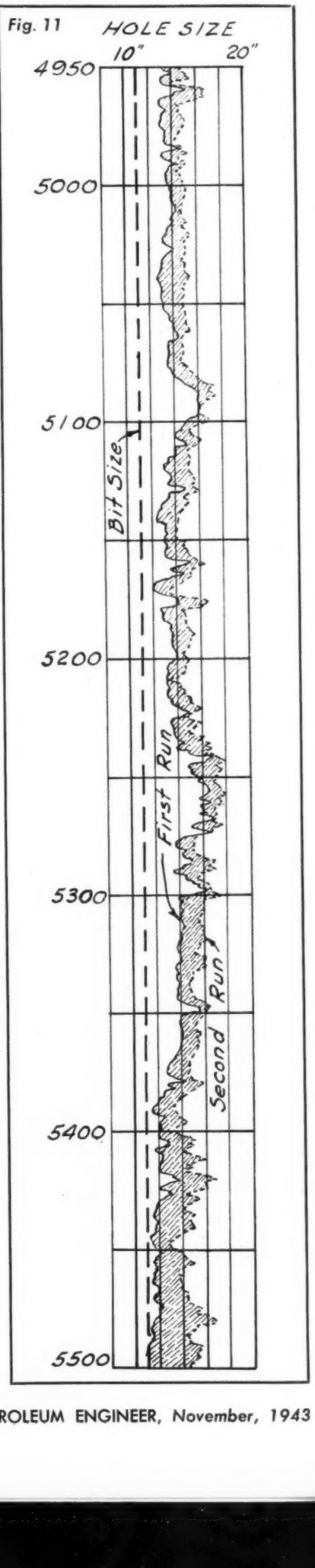


Fig. 11



the hole to the required height for this operation, thereby saving the placing of a second plug.

This oversized hole is probably the cause of much drill pipe grief as the irregular and enlarged hole leads to excessive gyrations and much bending of the drill pipe.

Also note in Fig. 5 how the hole from 5500 to 5560 ft., together with the sandy shell at 5630 to 5635 ft., prevented the socket when run with drill collars from getting over the fish. With the drill collars removed and a bent 5-in. single a hold was secured.

Fig. 6 shows how mud cake forms on the walls of the hole after drilling and before running the liner. Notice that in 5 hours the wall cake had formed opposite the sands. Also, the enlarged hole under the water string shoe is typical of most runs.

Fig. 7 is another example of washout under the shoe. This time a surface string is shown.

Fig. 8 shows two runs with the caliper in a hole drilled with oil base drilling fluid. This hole stood 13 hours between runs yet no measurable cake had formed.

Fig. 9 shows a hole drilled with oil base drilling fluid. It is interesting that much of the hole is nearly to gauge although drilled in various sediments that themselves lead to enlargement with water base mud.

Wall scraping must be carefully done or the instrument blades will not perform their job. Two runs on one well, Fig. 10, illustrate how they had failed to scrape the hole to full gauge and a third run was required.

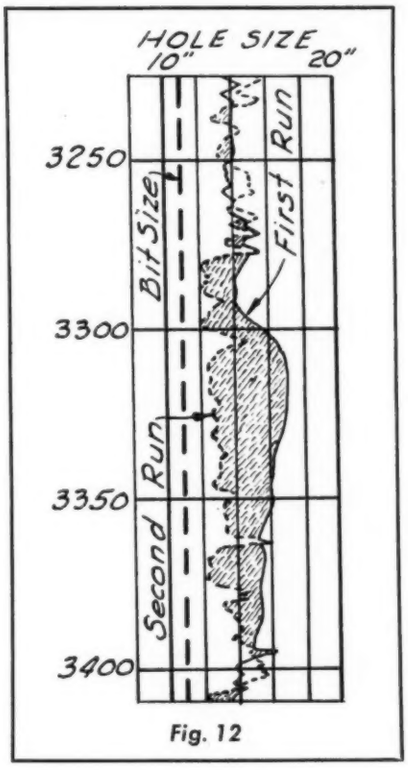


Fig. 12

Fig. 11 shows two runs in a hole with 94 days between runs. The increase in hole diameter is attributed to the water loss in the mud. That is, the water loss of the mud dissolves the shale. This action goes on until such a thick cake is formed that no more water from the mud can reach the formation. Then the action reverses and the cake builds up, filling the hole opposite these cavities. This, of course, is one cause of stuck drill pipe when coming out of the hole.

Fig. 12 is a part of the same run illustrating the action mentioned above. Here the cave has filled with mud cake and a potential stuck drill pipe job is present.

Conclusion

The oil industry has much to learn about the bore of the holes from which they draw their crude. More study should be made of this information by the technical branch of the industry as much new data can be obtained and many savings made by use of the caliper.

Other applications are being tried and their results will become known as the method demonstrates its usefulness. Quite likely improved initial production from wells drilled in developed territories will result from the study of the caliper runs.

A new study of circulating fluid is also indicated from the scant data now available.

The use of the caliper has added much accurate information to what was one of the unknowns in the oil industry.

☆ ☆ ☆

Testing Shear Strength of Spot Welds

P 590.6

A QUICK, simple method for shop testing strength and soundness of spot welds has been developed in the East Springfield, Massachusetts, plant of the Westinghouse Electric and Manufacturing Company. Spot welding is usually tested by "pulling a button" but this only tells if the material actually welded, failing to give any indication of strength or soundness of weld.

A small shear testing machine is now used to make a thorough test. When an inspector desires to make such a test he takes two standard test pieces, cleans the surfaces and makes the weld by overlapping the two pieces. The welded specimen is then clamped in the machine and a shear is applied. The force applied in pounds is shown by a gauge on the machine.

Advantages gained from the use of the shear testing machine are: (a) aids in control of quality by giving a quantitative value of the strength of the weld; (b) serves as a quick check on setup of spot welder; (c) compact and simple to operate, and (d) permits tests to be made by operator or floor inspector instead of a laboratory technician.

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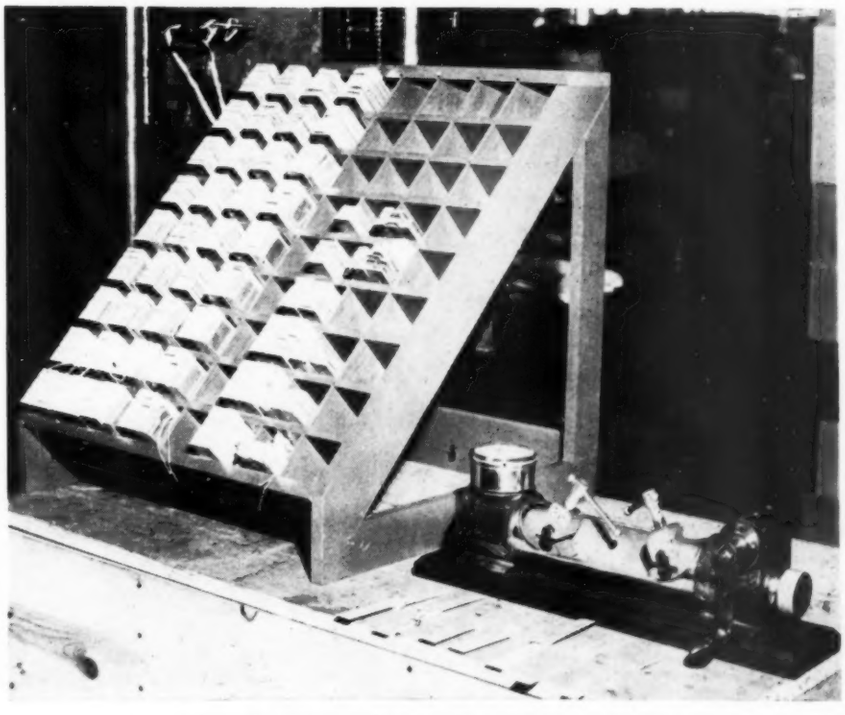
Shear testing machine and rack for test pieces

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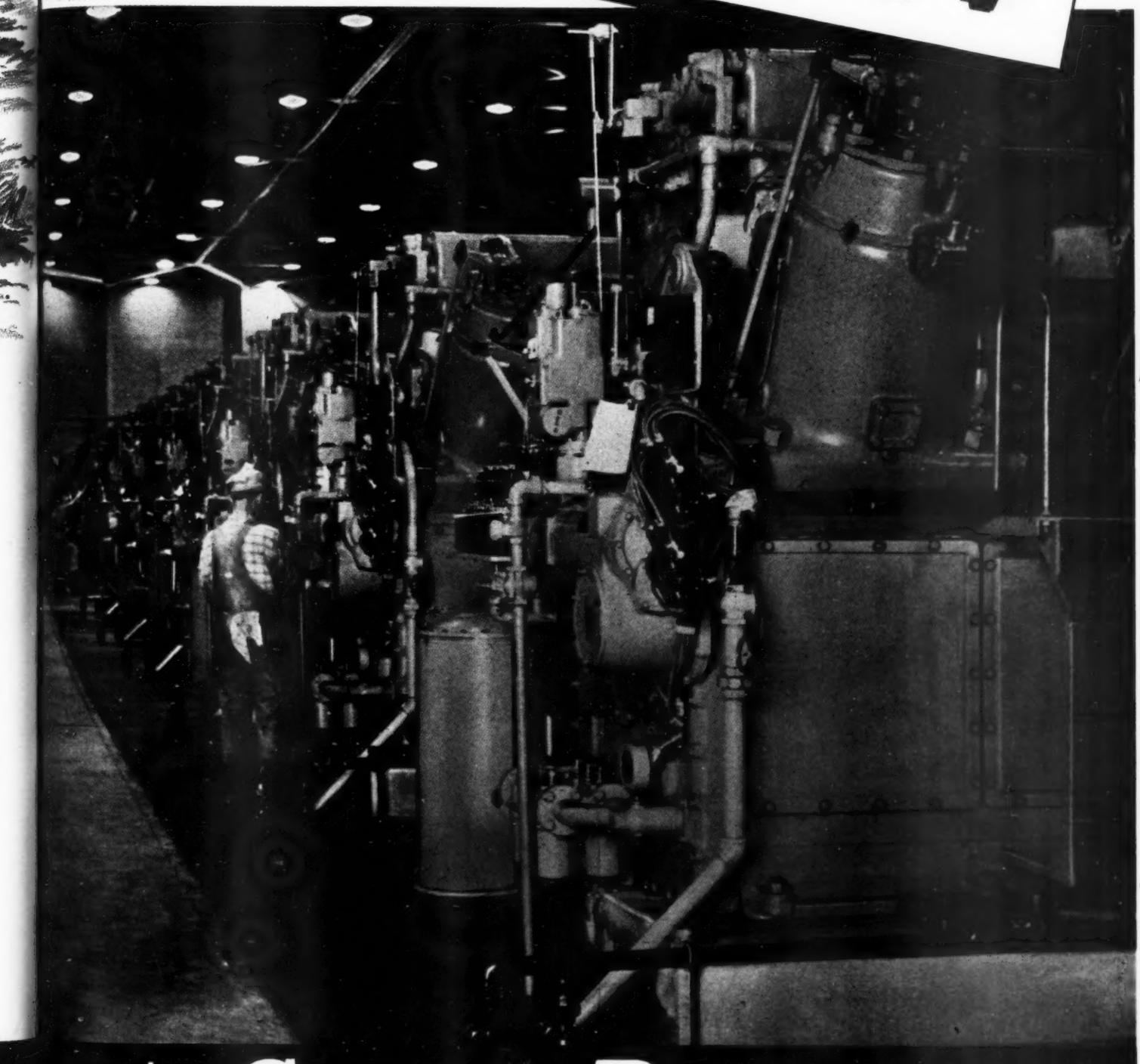

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Estimating Ultimate Recovery

Exclusive

☆ Prorated leases present problem requiring special solution

by Charles H. Rankin
Consulting Engineer

THE problem of estimating the ultimate recovery from a lease that has been operated under proration is a difficult one if attacked by the methods that have been commonly used in the past.

A study of Fig. 1, the production curves of 5 tracts, shows clearly that to transfer these curves to semi-log or logarithmic paper would inevitably give a result that could easily be erroneous. The curves show a similarity that is entirely due to the allowable under which the leases have been produced and which bears no relation to the relative capacities of the tracts.

One tract in the group studied has not been able to meet the allowed figure. This tract B is in the marginal classification. The other tracts have each been able to meet the allowed figure.

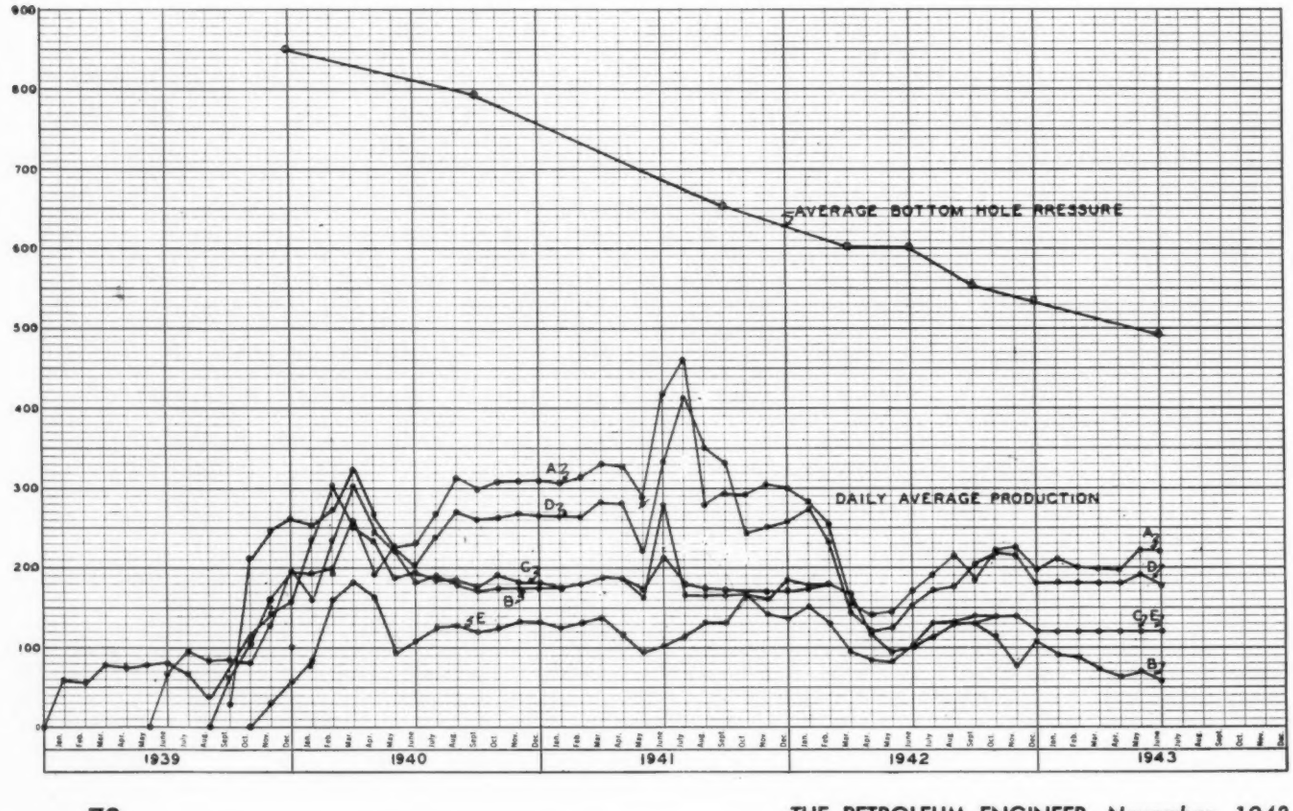
Fig. 2 shows a method of determining the relative capacities of the leases as well as their indicated ultimate recoveries. In this figure the average bottom-hole pressures on each tract have been plotted against the cumulative recovery. It will be noted that there is a wide dissimilarity in the curves shown by this method of plotting. Tracts E and C in Fig. 1 show production curves that are so alike that they overlap in many places. In Fig. 2 the indicated recovery from tract C is nearly three times the indicated recovery from tract E. Similarly tracts A and D, which nearly coincide in Fig. 1, show dissimilar curves and indicated recoveries in Fig. 2.

The following table shows the interpretations derived from the projection of the curves on Fig. 2:

Tract	*No. wells*	*Indicated recovery*	*Indicated recovery per well*	*Indicated recovery per acre*
A	7	690,000	98,600	2480
B	4	265,000	41,250	1030
C	4	900,000	225,000	5600
D	6	1,000,000	166,000	4180
E	4	365,000	91,200	2030

There are other interesting conclusions to be drawn from the curves in the figures shown. The bottom-hole pressure curve in Fig. 1 shows the relationship that exists between rate of

Fig. 1



Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

PETROLEUM ENGINEER EDITION

THE BAASH-ROSS *Controlled action* PACKING ADAPTER

A NEW BAASH-ROSS TOOL TO SIMPLIFY AND SAFEGUARD YOUR PRODUCTION OPERATIONS

ONE of the most important factors in the success of modern cementing and production operations is that you have *complete control* over your pack-off equipment at all times. And in wells where bridges or tight spots are encountered—or where the liner is set against bottom—conventional packers generally do not offer the full control so essential to today's production methods.

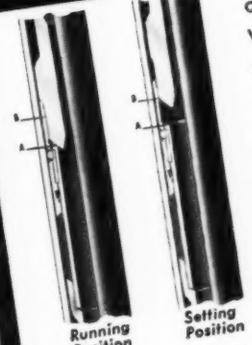
The new Baash-Ross Controlled Action Packing Adapter is particularly engineered for just such operating conditions. It will not set accidentally, even under adverse hole conditions... it requires *no dangerous torque* in the string for operation (vitally important where tubing is used)... and yet pack-off is simple, positive, *and under full control from the surface at all times—without risky left-handing of string.*

WHAT IT IS The Controlled Action Packer is similar in appearance to a conventional type packer, but is so constructed that the packing element cannot be expanded until the setting tool is backed off a number of revolutions. Then, by simply setting the weight of the string back down, the seal is expanded. There are no spring-actuated parts to stick or complex mechanisms to jam—nothing to interfere with positive operation.

HOW IT WORKS Note the unusually simple, safe operation of this tool. When the packer assembly is made up on the liner or casing section it is attached to the setting tool by means of the coarse left-hand thread. When the setting tool is in full thread engagement, the end of the setting tool rests against the shoulder "A", thus locking the sleeve "B" against movement with respect to the body of the packer. You can run the packer assembly into bridges and tight spots, you can work it through windows, or you can even strike the bottom of the hole without risk of expanding the packing element.

When you are ready to set the packer, the operation is simple. You merely back off the run-in string about ten turns to the right and set the weight down, thus expanding the packing element. That's all there is to it.

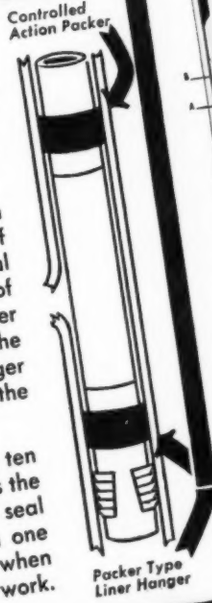
Backing off the run-in string lifts the setting tool a short distance above shoulder "A" so that when the weight is set down it is applied directly against the sleeve "B" instead of against the shoulder. As the sleeve is forced down, the packing element is expanded against the casing wall to form a fluid-tight seal. When the packing is expanded, a positive friction lock prevents the sliding sleeve from returning to its original position, and the run-in string can then be released. The entire setting action is fast—simple—and under full control at all times.



WHERE IT'S USED Wherever complete control of pack-off operations is required—whether in setting liners...cementing...making repairs on water strings ...or performing any other similar production work with maximum ease and safety—the Baash-Ross Controlled Action Packer is the ideal tool for the job.

For example, in "scabbing" operations the Packer can be run with a Baash-Ross Liner Hanger to seal off damaged or leaky casing. For this, a conventional packing-type liner hanger is run at the lower end of the scabbing sleeve and a Controlled Action Packer at the upper end. When the blank pipe is opposite the damaged section of casing, the bottom liner hanger is set in the usual manner by turning the string to the left and setting down to release the slips.

After the bottom packer is set, rotating the string ten turns to the right and again setting down expands the Controlled Action Packer above, completing the seal both above and below the damaged casing on one run into the hole. The packer is equally effective when cementing, setting liners and for other repair work.



▶ Your nearest Baash-Ross representative will be glad to show you how to simplify and safeguard *your* production operations with this latest Baash-Ross advancement. *Or write Baash-Ross direct!*

withdrawal as well as cumulative withdrawal. There is a point in most producing areas where the rate of withdrawal can be maintained and tends to minimize the decline in bottom-hole pressure. Recent studies of the East Texas field[1] indicate that when the rate of withdrawal for the field is less than 725,000 bbl. the natural forces will maintain the bottom-hole pressure. In a water drive field this does not necessarily mean that the wells will continue to produce oil. The ratio of oil to water produced may change considerably while there is little change in bottom-hole pressure.

Another interesting fact brought out by the curves in Fig. 2 is that a considerable change in the amount of recoverable oil can be brought about by any method that will tend to maintain the bottom-hole pressure, such as pressure maintenance. The extent to which this relationship may be changed is indicated by the experience in the Tepetate field.[2] Under pressure maintenance it is estimated the recovery will be 150 to 175 percent of the ultimate that would have been recovered by ordinary methods.

[1]"Subsurface Disposal of Salt Water in the East Texas Field," by W. S. Morris, *The Petroleum Engineer*, July, 1943, P. 41.

[2]"Tepetate—Six Years Later," by E. O. Bennett and F. B. Haverfield, *The Petroleum Engineer*, Reference Annual (July 1), 1943, P. 337.

☆ ☆ ☆

OIL OUTPUT DECLINED IN 1942

Production of crude oil amounted to 1,386,645,000 bbl. in 1942, it is shown in a report by the U. S. Bureau of Mines.

Compared with 1941, the principal gains in crude oil production were 18,000,000 bbl. for California, 14,000,000 bbl. for Kansas, 14,000,000 bbl. for Mississippi, 5,000,000 bbl. for Michigan, and 3,000,000 bbl. for Wyoming.

Production declines of 22,000,000 bbl. in Texas, 26,000,000 bbl. in Illinois, 14,000,000 bbl. in Oklahoma, and 9,000,000 bbl. in New Mexico more than offset the increases and resulted in a decline in total crude production of about 16,000,000 bbl.

The average value of crude petroleum at the wells rose from $1.14 a bbl. in 1941 to $1.19 a bbl. in 1942.

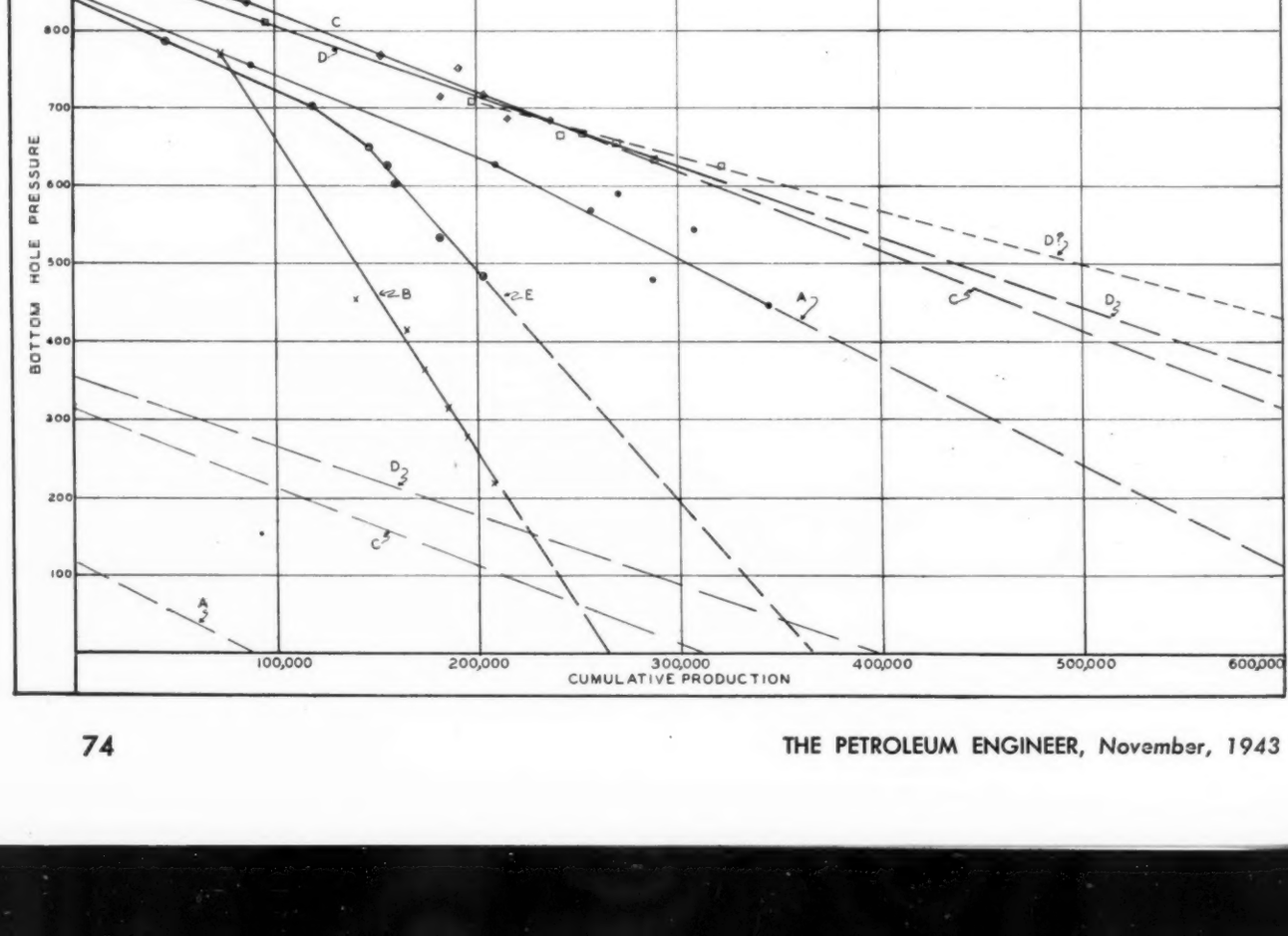
The number of producing wells in the United States increased from 399,960 on December 31, 1941, to 404,840 wells on December 31, 1942. The number of wells drilled for oil and gas declined sharply from 29,070 in 1941 to only 17,934 in 1942. The number of dry holes increased from 24 percent of the total in 1941 to 31 percent of the total in 1942.

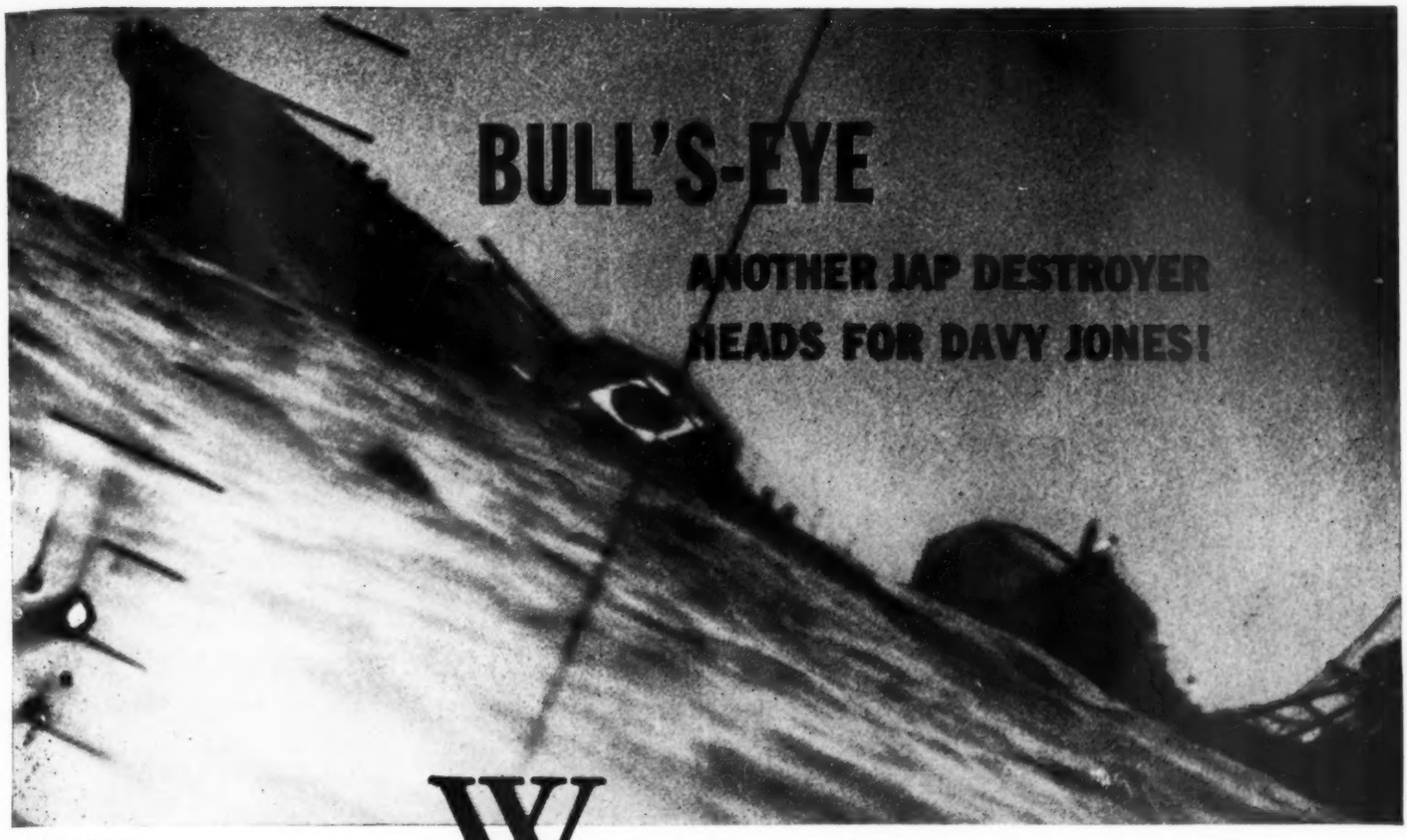
The total demand for domestic crude petroleum dropped from 1,421,000,000 bbl. in 1941 to 1,396,000,000 in 1942. Production was supplemented by a decline of 9,500,000 bbl. in crude stocks of domestic origin. Stocks of domestic and foreign crude oil amounted to 245,754,000 bbl. on December 31, 1942, compared with 257,678,000 bbl. on January 1, 1943.

Crude runs to stills declined from the 1941 peak to 1,334,103,000 bbl. in 1942, a loss of 75,000,000 bbl. or more than 5 percent. Foreign crude runs were reduced by 36,000,000 bbl. and domestic runs by 39,000,000 bbl. Gasoline yield decreased from 44.2 percent in 1941 to 39.8 percent in 1942, the yield of residual fuel oil from 24.3 percent in 1941 to 26.9 percent and the yield of distillate fuel oil increased from 13.4 percent in 1941 to 14.7 percent.

Stocks of all oils amounted to 497,940,000 bbl. at the end of 1942, a decline of 58,500,000 bbl. Stocks of refined oils dropped 46,800,000 bbl. and stocks of crude petroleum were reduced by 11,900,000 bbl.

Fig. 2





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Milling a batch of synthetic rubber

Exclusive

by
Wallace A. Sawdon
Pacific Coast and Foreign Editor

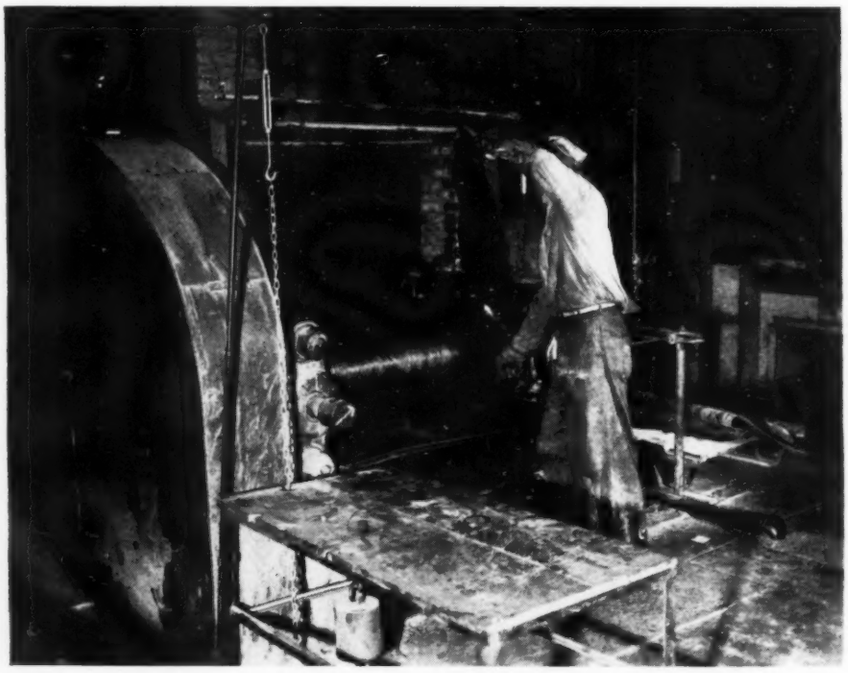
Utilization of Synthetic Rubber in Oil Industry

Advancements extend synthetic's adaptability for use in manufacture of oil field equipment

MUCH has been published about the manufacture of synthetic rubber and its general possibilities as a replacement for natural rubber. As many oil tools and much equipment for oil wells require rubber for their operation, the adaptability of synthetic rubber for effective performance should be given due consideration. Neoprene has long been used to overcome the effects of oil and gas on rubber exposed to these fluids in oil wells, but a more extensive use of synthetic rubber in oil equipment did not result because of the cost and the previous lack of development in products that provide qualities necessary to meet general requirements. The synthetic rubber aspect has now changed and research has provided products that are adaptable to oil equipment design and operation. A great synthetic industry has been built up by the war and in the opinion of the writer this industry is not going to be junked when the war is over. Moreover, research is going to continue and it can be expected that synthetic rubber will be manufactured with characteristics better able to meet specific requirements than those of natural rubber.

Use in Equipment

The time has already come when the adaptability of synthetic rubber to oil equipment is being given intelligent consideration because it now plays a vital role in manufactured products for the petroleum industry. Casing protectors have been made entirely of rubber. Rubber likewise plays an important part in the fabrication of pipe wipers,



The warm up mill

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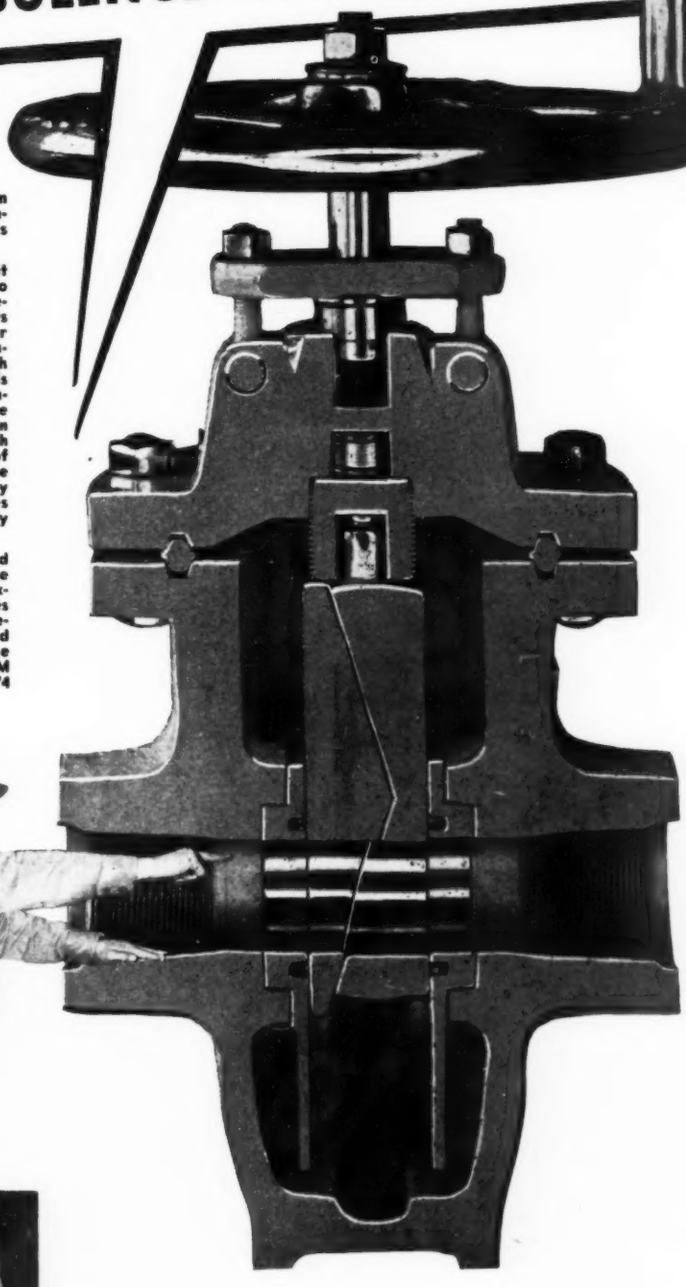
NO TURBULENCE—NO CUTTING



This cut-away view of a W-K-M Gate Valve in open position clearly reveals its unique mechanical features which have made it the industry's first choice in gate valves.

Note its smooth, cylindrical through-conduit which is sealed on both sides of the gate. No other gate valve has this feature, and, consequently, it is the only gate valve whose seats are never exposed to pressure in either open or closed position. There are no cavities or irregularities in the flow-way to collect sand or trash and thus prevent full closure of the gate. This feature also eliminates turbulence and its harmful cutting and confines the pressure to the smallest space. Patented bronze combination wipe-and-seal rings are in constant contact with the gate, wiping it clean with each operation of the valve and sealing the grease-packed valve body against pressure and foreign matter. Any sediment carried down with the gate as it closes cannot enter the valve body and is immediately flushed out upon opening the valve.

Easy opening and closing under full rated pressure, renewable bronze seats, double-wedge gate construction to assure uniform parallel expansion and a pressure-tight seal on both sides of the valve . . . these and other mechanical refinements of W-K-M Gate Valves are explained and illustrated in literature which will gladly be sent to interested operators on request. W-K-M Company, Houston, Texas. Export Office: 74 Trinity Place, New York, New York.

There's 3300 lbs. pressure on this W-K-M Gate Valve installed on a high-pressure Christmas tree manifold. In service for several years and requiring frequent opening and closing, this valve has shown no signs of leakage or of being hard to operate.

W·K·M GATE VALVES

Cost No More than Ordinary Valves

wire line guides, and similar devices. For this reason the results obtained by Patterson-Ballagh Corporation in using synthetic rubber for the construction of such equipment serves as a yardstick for the comparison of synthetic and natural rubber.

The particular synthetic rubber developed for oil field service is known by the trade name PBX. A comparison of this synthetic with natural rubber is shown in Fig. 1 with curves for each plotted to show the tensile strength at various percentages of elongation. The ultimate tensile strength and elongation at the point of failure of synthetic blends used to date are not so great as those of natural rubber. On the other hand, the tensile strength while being elongated in the services for which they were designed is greater for the synthetic than that of the natural rubber. Moreover, the synthetic has other characteristics that are very valuable when used in oil field equipment. The PBX blend developed compares favorably with any synthetic developed to date as far as its resistance to the deteriorating effects of oil and gas are concerned. This is in contrast to natural rubber, which absorbs oil and gas and expands very freely, swelling greatly in the process of absorption, with consequent disintegration and loss of elasticity.

Resistance to abrasion has also been found adequate for the service in which protectors made of synthetic rubber are placed. Other advantageous factors in PBX synthetic rubber are found in its resistance to the action of the sun's rays. It can be exposed to sun and adverse climatic conditions without deterioration. Thus it is more suitable to tropical application than natural rubber. This is of special importance in overseas operation. Although protectors made with the new blend have been in service for some time the period has been too short to allow accurate estimates of ultimate life.

Development

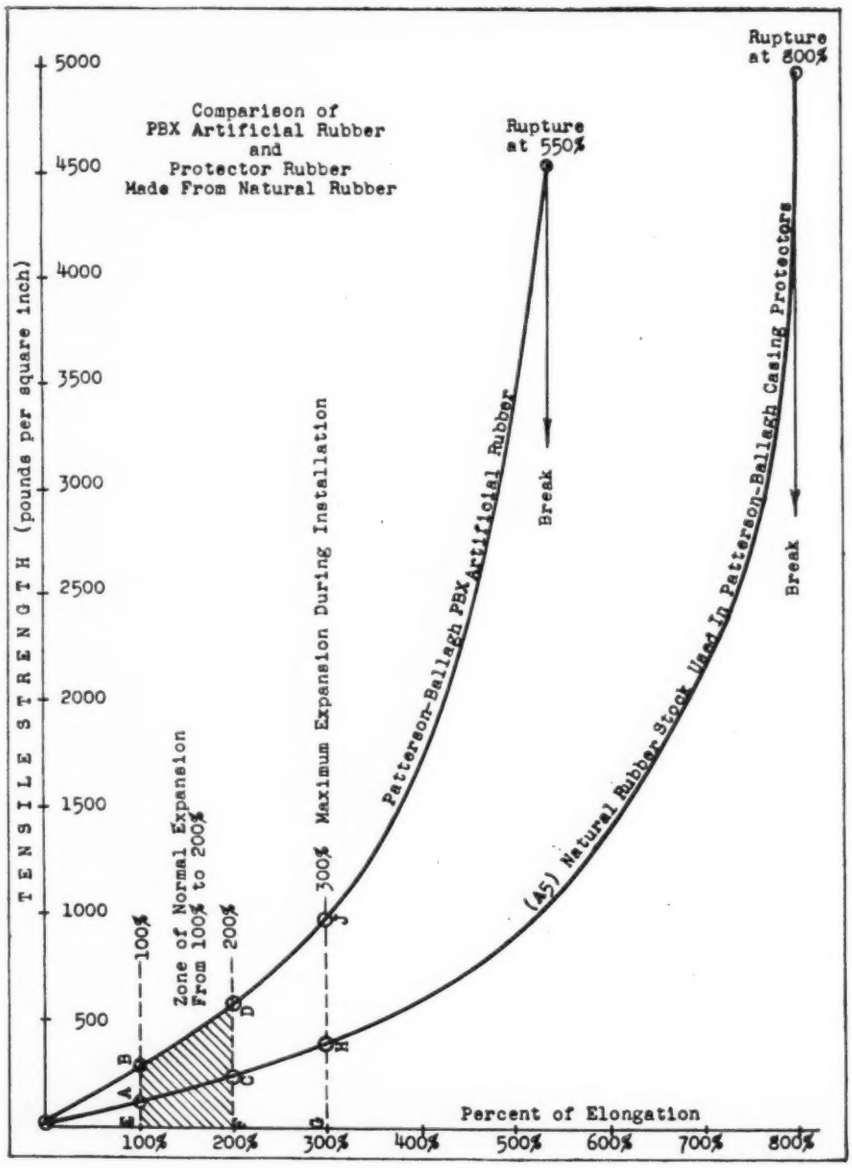
The company has experimented for years with certain base material and with synthetic rubber because of the difficulties experienced when rubber was exposed to oil or gas. The cost of manufacturing protectors from these materials was prohibitive during that time. Despite the price factor many desirable devices used in the oil industry such as oil-proof wire line guides, wire line wipers, packers, etc., were manufactured. The first protectors made entirely of synthetic materials were manufactured as experiments in 1940.

Approximately a year ago the War Production Board allocated to this company synthetic rubber for purposes of experiment because the company was active in the manufacture of devices considered important to the war effort. Owing to the conversion of a large part of its plant to war work, in which synthetic rubber is used exclusively, invaluable experience has been gained. Through this experimental and development work it has learned how to mix, mill, tube, and fabricate the synthetic product. The knowledge gained is being utilized in the blending of an artificial rubber suitable for oil field products. At present all the synthetic rubber necessary for the manufacture of oil field products has been made available.

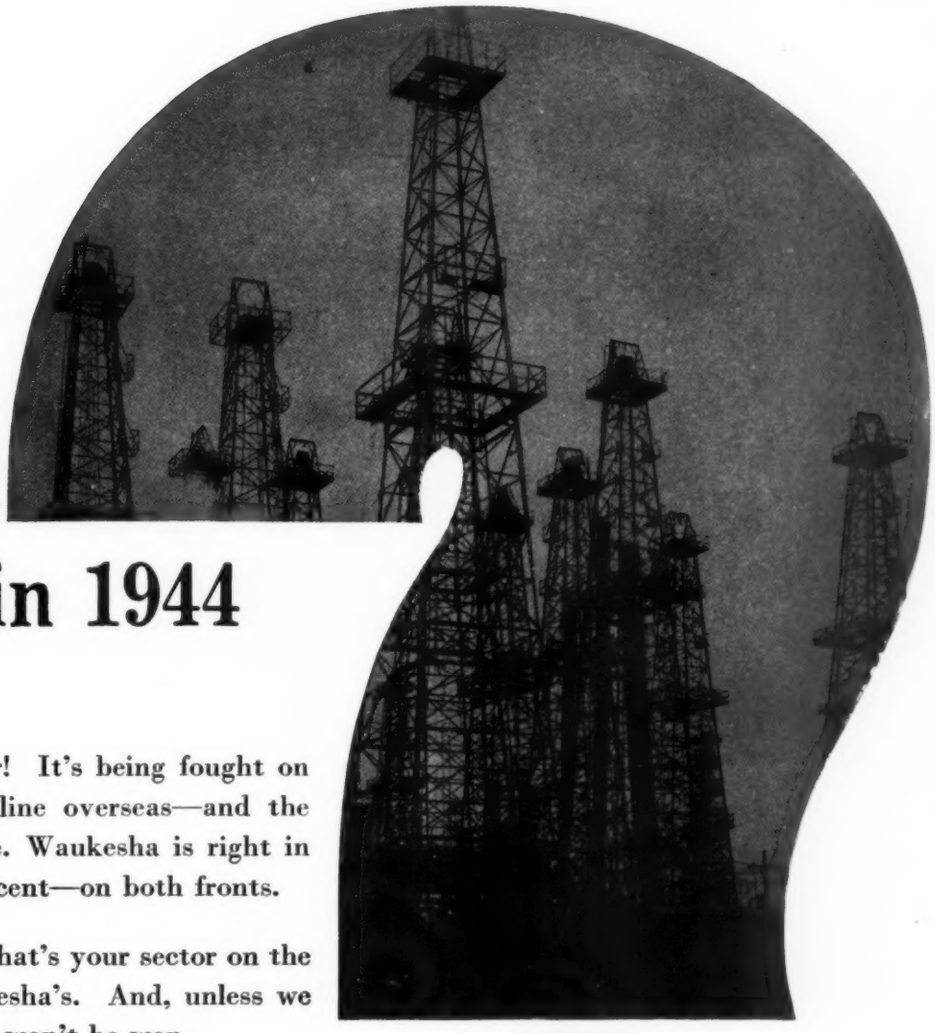
There are many types and grades of natural rubber the best of which is called plantation and is grown under ideal conditions. Even plantation rubber is not always uniform in quality. Synthetic rubber provides the ideal conditions for positive manufacturing control. This may be attributed to the fact that the raw chemical products used in producing synthetic blends may be accurately checked and measured. It is

Fig. 1

Shaded area, B E F D, covers the stretch to which the protector is subjected while on the drill pipe. This is the measure of the "grip" with which the protector adheres to the pipe. Although the ultimate strength of the natural rubber is greater than that of artificial rubber, the strength at the critical expansion range is greater for the artificial rubber (BD) than for the natural rubber (AC). The line G-J marks the maximum expansion to which the protector is subjected during the expansion over the tool joint. From this it is seen that there is a rapid increase in the power that will be required to expand PBX over that needed for the expansion of natural rubber. It is, however, well within the range of elasticity so that no "permanent stretch" will be placed in the protector. The increase in power needed for the installation means that installation tools being subjected to this heavier load will probably require more service than those used with protectors made from natural rubber. More power will be required in the removal of the protectors.



What are you going to do about engines in 1944



● This is an all-out war! It's being fought on two fronts—the battle line overseas—and the production line at home. Waukesha is right in there fighting—100 per cent—on both fronts.

● Oil is ammunition! That's your sector on the battle lines—and Waukesha's. And, unless we pull together, the battle won't be won.

● This means, briefly—that you and other oil field engine users must tell us *approximately how many* Waukesha Oil Field Engines you'll need in 1944—and when you want them. If you can't place an order—at least estimate your future needs.

● On the basis of your orders and estimated needs for 1944, Waukesha will plan its production schedule.

● Will you give us this vital-to-victory information *now?*

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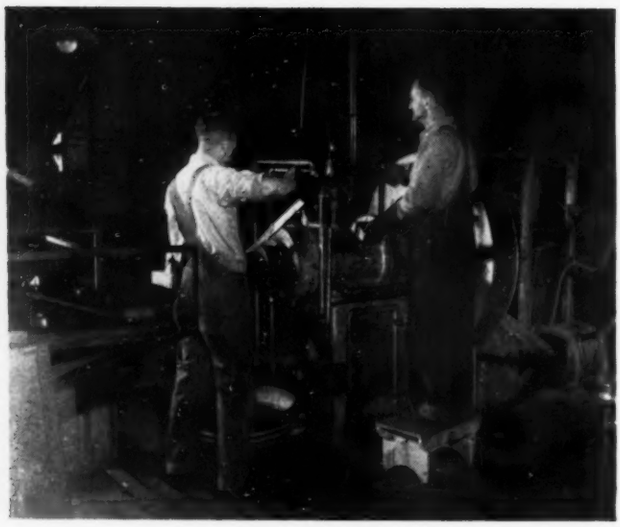

Tubing out the slugs

Weighing slugs before moulding

therefore more uniform when received by the fabricator. From the many kinds of artificial rubber now being made it is possible to select the synthetic that meets the desired requirements. The desired characteristics and uniform quality of the finished artificial rubber are made through the selection of the proper raw synthetics. Moreover, continuing refining experiments may be conducted to improve the product to a greater degree, but this refinement is very limited in the case of natural rubber.

Synthetics are better than they were even a year ago, when experimental work was frequently necessary with each batch manufactured in order to obtain the proper blend. Now most synthetics are uniform and can be supplied to almost any desired specification. The development of synthetic rubber is fortunate for the oil industry because at this time there is a much greater than normal need for casing protectors. This is probably because much of the casing being used is in poor condition. Frequently it is secondhand, and the risk is too great to drill without protectors. Drill pipe that has passed its normal life and should have been discarded must be employed. Moreover, crews are inexperienced, labor is high and with the elements of cost in a well thus increased all precautions must be taken in drilling operations.

War has brought on circumstances over which none of us has control. The synthetic program has brought down the price of artificial rubber almost to the price to which natural rubber has advanced in the last few years. This leveling off of prices has made it possible to convert from natural rubber, which is getting scarce, to synthetic, which is getting more and more plentiful, on an economical basis.

Synthetic rubber weighs about one-third more than natural rubber; therefore the basic cost, by volume, is greater. The advantages of synthetic rubber, even at a slight advance, seem to offset this disadvantage.

It is quite probable that there will always be a market for protectors made from natural rubber if and when natural rubber is available at the low prices that have prevailed in years gone by, for price is always a factor in any equipment consideration. One of the developments on the plus side of the war emergency is the rapid improvement in artificial rubber, an improvement that might otherwise have taken years to develop.

—— ☆ ☆ ☆ ——

Moulding synthetic rubber protectors

Trimming external portion of protectors

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Repairing Oil Tanks by Arc Welding[1]

☆ Method is described that effects 42 percent saving in construction cost

by E. G. Woolman
Welding Foreman,
Cities Service Oil Company

THE widespread use of arc welding in producing strong, corrosion-resisting tanks of leak-proof construction has become standard practice in the storage and processing of petroleum products as well as in many other industries.

The method of arc welding described in this article is used to place a storage or working tank back in service after the bottom corrodes so badly that leaks develop; tanks that have been in gasoline, naphtha, gas oil, and crude oil service are renewed.

Steaming the tank is first necessary in order to remove all vapors that might cause a fire or explosion. The old bottom is cleaned by sprinkling Fuller's earth on it, then sweeping and removing the oily earth.

A section, 6 ft. by 6 in., cut from the side and close to the bottom of the tank, allows material to be passed into the tank, thus eliminating the expense of removing and replacing a door sheet.

Figs. 1 to 7, inclusive, show the actual method of construction. A detail of the bottom in Fig. 5 illustrates how each sheet laps over the other, except the 3 in. section at the end, which is butt-welded to the adjoining sheet, forming a flat surface around the edge. Only one welding pass is run on the bottom sheets. The 12 in. slanting plate rests on this flat surface, and is welded to it in two passes. The top of this slanting plate, resting on the side of the tank, is welded to the tank, two beads being run.

At each rivet seam a notch is cut, as shown in Figs. 2, 3, and 4, and then welded. This prevents liquid from seeping in behind the rivets, running down the seam in back of the slanting plate, and underneath the new bottom.

After the new bottom is installed, the section cut out to act as a door sheet (see Fig. 6) is welded back into place. There is no need to make this weld tight, as it has been cut below the level where the slanting plate on the inside is welded to the side of the tank. The top weld on the slanting plate has already formed the liquid seal.

The cost figures given below are for a 1250 bbl. tank (52,500 gal.). Advantages of this method are that it is cheaper and faster than the old method of installing a new riveted bottom. To install this type bottom by riveting would be an impossibility.

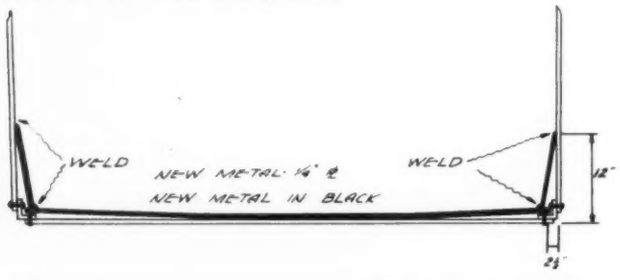
Corrosion has been found to be most severe around the angle iron and old rivets, sometimes extending 3 and 4 in. up the side of the tank. The arc-welding method will take care of any such corrosion difficulties, forming a bottom that will not break or pull away from

(Continued on Page 85)

[1]From a paper submitted in the Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Fig. 1. (Below) Cross-section of tank bottom

Fig. 2. (Right) Inside view of tank rivet seam showing notch to be cut out to act as liquid seal



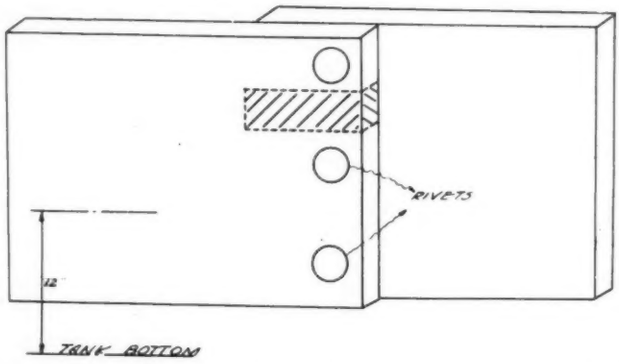


Fig. 3. Inside view of tank rivet seam showing notch after cutting

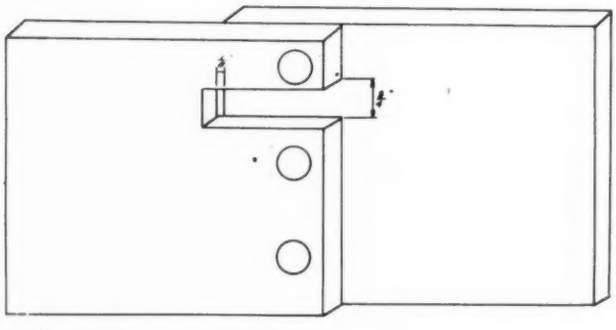
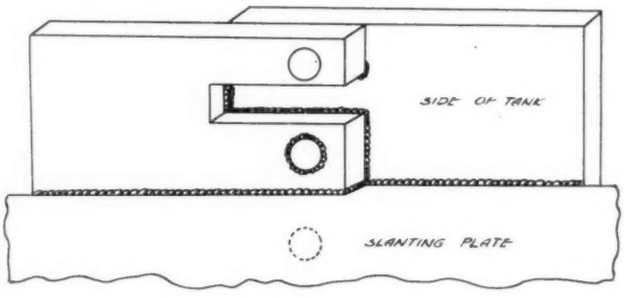


Fig. 4. Finished construction showing welding of notch, rivet head, and slanting plate



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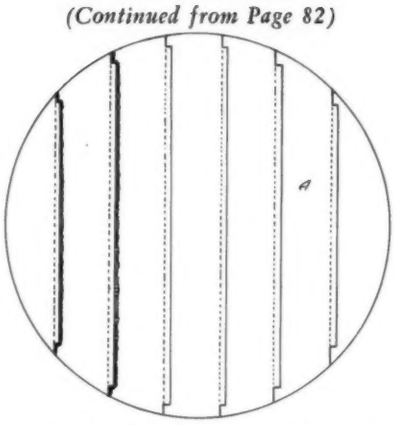


Fig. 5. New bottom showing how sheets are to be welded together. Notch is cut in sheet so that surface around edge will be flat

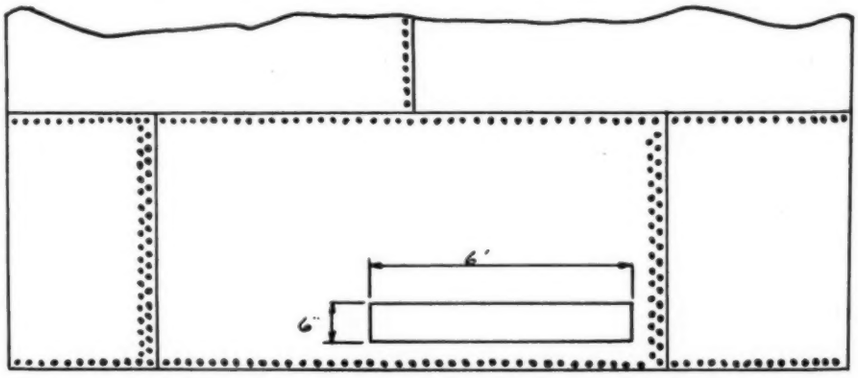
Fig. 6. Side view of tank showing section to be cut out to take place of door sheet

the sides. In the welded structure the bottom is free to work around due to the slanting plate being welded to the side. The tank described is 30 ft. in diameter and approximately 11 ft. high.

Summary of costs

Material cost of parts welded	$400.00
Cost of cutting and forming	40.00
Cost of fitting up	5.00
Power consumed: 42 hr. @ 10 cents per hr.	4.20
Cost of electrodes: 200 lb. @ 10c per lb.	20.00
Labor: Welders, 42 man-hours @ $1.17 per hr.	49.14
Helpers, 42 man-hours @ $0.92 per hr.	38.64
Overhead	20.00
Total	$576.98

Had a new riveted bottom been installed, the cost for material and labor would have been approximately $1000.



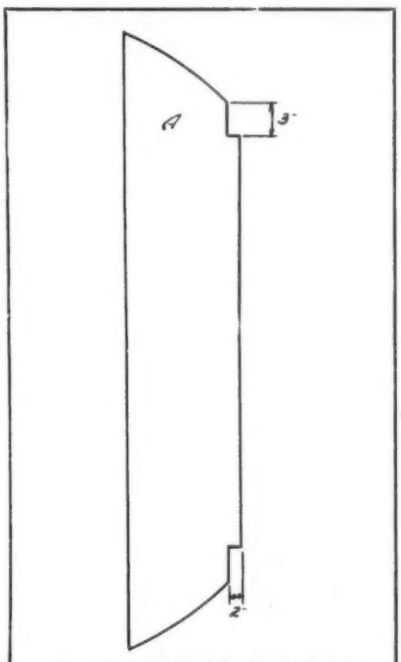


Fig. 7. Detail of bottom sheet

It is estimated that at least ten tanks are renewed yearly by this method by our company, which results in an approximate yearly saving of $4230. As the new welded bottom is equally as efficient as the original riveted one, the life of a tank is doubled by this method. The welding machine used is an electrically-driven 300 amp. welder. Welding rod used is 3/16 in. in diameter for mild steel.

☆ ☆ ☆

Vinson's Turndown Brings Retorts

When the much delayed decision to refuse the general increase in oil prices of 35 cents a barrel was released by Fred M. Vinson, director of economic stabilization, indignation of oil men and officials of oil states was sharp. Below are some comments that index the general feeling:

"Increased drilling in proven areas, which Mr. Vinson estimates may amount to 19,000 wells in 1944, will accelerate the exhaustion of those reserves. The petroleum industry is liquidating itself now at prices below replacement costs."

—D. A. Little, president, Magnolia Petroleum Company.

"The administration can't give 35 cents a barrel increase for oil but it can for whiskey."

—Representative Wesley E. Disney of Oklahoma.

"Every effort now should be directed to congress and to members from non-oil producing states. Every oil man should get busy at once and contact members of congress demanding that quick action be taken on the crude oil price matter. Unless something is done shortly the nation will suffer from lack of oil."

—Andrew Rowley, Tulsa Tribune oil editor.

"Too much theory and not enough practical knowledge is being used in management of the oil problem, and it looks like we are going back to the horse and buggy days, except we'll be minus the horse . . . The oil situation is the most serious confronting the American home front today. It is being manhandled."

—Gov. John J. Dempsey of New Mexico.

"Wages in the oil industry have risen 48 percent since 1939. Material costs have increased 19 percent. The actual out-of-pocket costs of drilling wildcat wells have jumped 50 percent in the last two years."

—S. Maston Nixon, president, Texas Mid-Continent Oil and Gas Association.

"Oil men abhor strikes, but they fear that there will be another type of walk-out, shutdown, and work stoppage. Many operators are unwilling to continue to drain their reserves without compensation and the informal halting of production may sweep over many states and affect the production of by-products used in making essential materials for war."

—Paul S. Hedrick, Tulsa World oil editor.

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Calculating Fractional Contents of Horizontal Cylindrical Tank

Method of strapping a tank and calculating a gauge table from results

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

STRAPPING a tank and calculating a gauge table from the results is generally looked upon as a special skill possessed only by expert calculator operators and surveyors. This is true only in the sense that extreme accuracy both in measurements and calculations is required. An error of infinitesimal proportions either in the strapping or the calculations can cause a loss of perhaps $20,000 in the life of a 100,000 bbl. tank from which regular movements of even medium value stocks are made. Therefore, a few hundred dollars spent for an accurate gauge table for such a tank is good insurance against monetary loss.

There are many times, however, when a refinery operator needs the same information regarding some of his operating tanks that have not been professionally strapped because movements in or out of the tank have no fiscal significance. As the refinery man is interested only from an operating angle, he is not always concerned with extreme accuracy and, therefore, hesitates to make the expenditure for a professional strapping. In any case he usually wants and needs the information immediately, not when the strapper can get around to doing the work.

If the tank is the conventional cylindrical tank in vertical position he has available tables from many sources from which a gauge table of sufficient accuracy can be quickly made. If none of the standard sources is at hand a calculation of gal. or bbl. per in. of height can be made in 10 minutes. The formula is simple and fundamental:

$$\frac{\text{diameter in in.}^2 \times 0.7854}{231} =$$

gal. per in. of height.

This figure can then be transformed into the desired fractions of an inch and/or into barrels instead of gallons.

The calculations involved in making a gauge table for a cylindrical tank in horizontal position is quite another matter, particularly if it has bumped ends, which would generally be the case with a refinery tank, as the reason for the use of such a tank is for pressure storage, making the use of bumped heads imperative. Advanced manufacturing technique has made practicable the spinning of these heads with radius equal to radius of the cylindrical portion, which makes the vessel practically equal to a sphere in resistance to rupture by internal pressure. The extra cost of such heads is not warranted for the usual operating sizes and pressures, and the standard custom of spinning the heads with radius equal to diameter of the cylindrical section is usually specified for low-pressure storage vessels. The accompanying tables and instructions are based upon the latter assumption.

An example is a tank 8 ft. 1½ in. in diameter by 18 ft. 10½ in. long. First, the total capacity of the tank must be known, which figure will be the sum of the content of the cylindrical section and both bumped ends. The capacity of the cylindrical portion in gal. will be: 0.0034 × diameter in in.^{2} × length in in., and the bumped ends will contain: 0.0004666 × diameter in in.^{3}.

The calculation for the cylindrical section of the example tank is: 0.0034 × 97.5^2 × 226.5 = 7320.48. For the bumped ends: 0.0004666 × 97.5^3 = 432.47. Total capacity of tank, 7752.95 gal.

The Gauge Table

There are no short cuts in preparing the table. A calculator should be used whenever possible instead of a slide rule in the interest of accuracy.

Assume the graduation is desired by ¼ in. Set down these increments in a vertical column as shown in Table 1. Set up 97.5 as a divisor in the machine and calculate the percentages of the diameter for each ¼ in. in depth until one-half the diameter, which in this case is 4 ft. ¾ in., has been reached. Set these percentages down opposite each of the gauge divisions. The value for ¼ in. is 0.26 percent. Consult Table 2 for the percent capacity of cylindrical portion only represented by this percent of diameter. By some rather rough interpolation this is found to be 0.0215 percent. Follow this procedure until the half point has been reached. Now by taking the percentage c times the value of 7320.48 we can set down the gal. for each of the ¼ in. increments up to midpoint of the tank.

Capacities of Bumped Heads

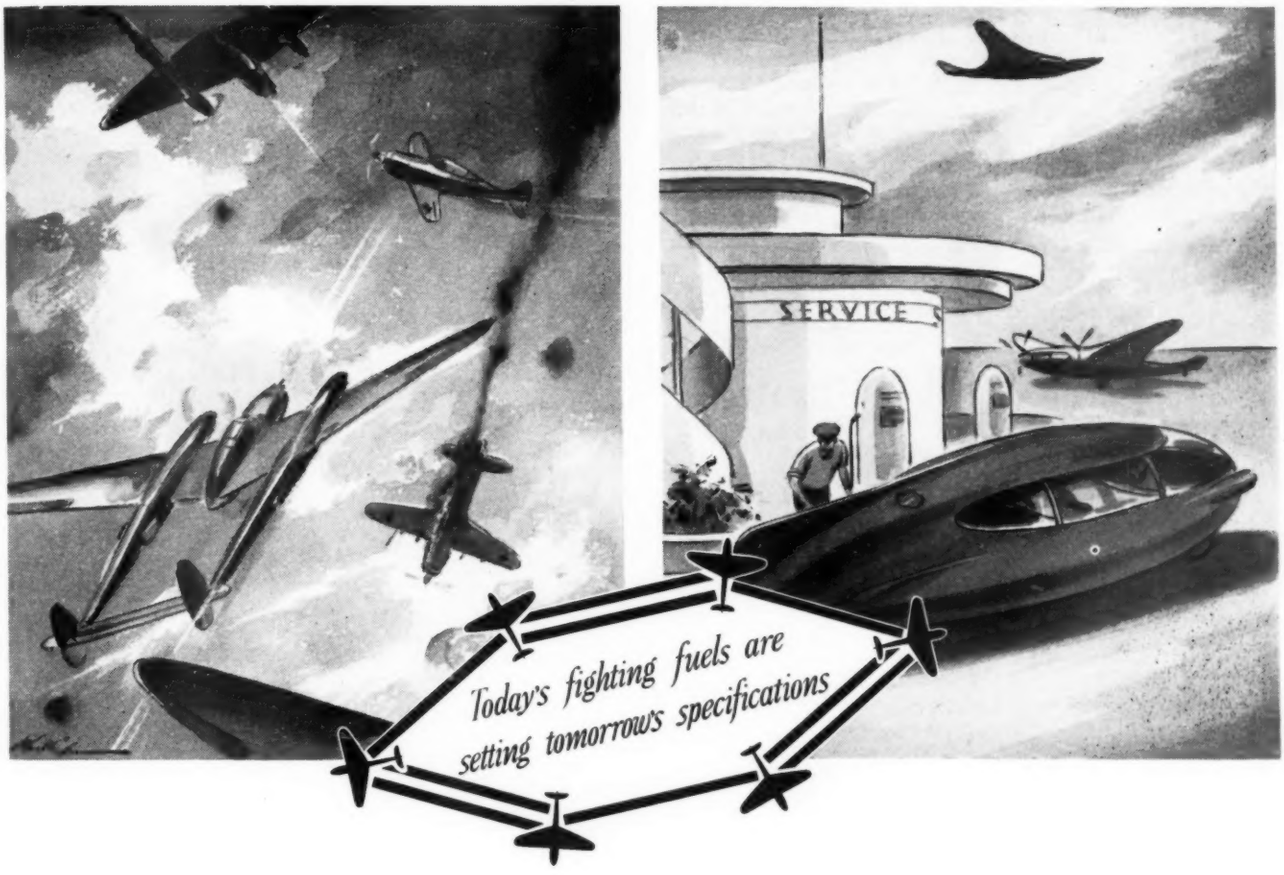
Turn now to Table 3 and find that the percent of diameter represented by ¼ in. is a negligible quantity. This is to be expected, but to make the gauge table complete we will set up an arbitrary value of 0.01 percentage c up to and including ¼ in. gauge reading. As this represents less than two ounces we can forget any greater accuracy. Now run these multiplications off on the cal-

TABLE I

Table for gauging horizontal cylindrical tank with bumped ends

8 ft. 1½ in. diameter by 18 ft. 10½ in. long.

Gauge	Cylindrical portion			Bumped ends		Total
Ft. In.	% d	% c	Gal.	% c	Gal.	gal.
0- 0¼	0.26	0.0215	1.57	0.01	0.04	1.61
0- 0½	0.51	0.0610	4.47	0.01	0.04	4.51
0- 0¾	0.27	0.1112	8.14	0.01	0.04	8.18
0- 1	1.03	0.1792	13.12	0.01	0.04	13.16
0- 1¼	1.28	0.2408	17.63	0.01	0.04	17.67
0- 1½	1.54	0.3119	22.83	0.02	0.08	22.91
0- 1¾	1.79	0.4099	30.01	0.02	0.08	30.09
0- 2	2.05	0.4973	36.40	0.03	0.13	36.53
0- 2¼	2.31	0.5901	43.20	0.04	0.173	43.37
0- 2½	2.56	0.7061	51.69	0.05	0.216	51.91
0- 2¾	2.82	0.7886	57.73	0.06	0.259	57.99
0- 3	3.08	0.9179	67.19	0.08	0.346	67.54
0- 3¼	3.33	1.0075	73.75	0.09	0.389	74.14
0- 3½	3.59	1.1470	83.97	0.12	0.519	84.49
0- 3¾	3.85	1.2921	94.59	0.15	0.649	95.24
0- 4	4.10	1.3920	101.90	0.17	0.735	102.64
0- 4¼	4.36	1.5461	113.19	0.20	0.865	114.05
0- 4½	4.62	1.6515	120.90	0.23	0.951	121.85
0- 4¾	4.87	1.8142	132.81	0.28	1.21	134.02
0- 5	5.13	1.8693	136.84	0.33	1.38	138.22
0- 5¼	5.38	2.0956	153.41	0.38	1.64	155.05
0- 5½	5.64	2.2116	161.90	0.41	1.77	163.67
0- 5¾	5.90	2.3895	174.92	0.47	2.03	176.95
0- 6	6.15	2.5715	188.25	0.52	2.25	190.50
0- 6¼	6.41	2.6952	197.30	0.54	2.34	199.64
0- 6½	6.67	2.8845	211.16	0.60	2.59	213.75
0- 6¾	6.92	3.0127	220.54	0.64	2.77	223.31
0- 7	7.18	3.2082	234.86	0.70	3.03	237.89
0- 7¼	7.44	3.3408	244.56	0.75	3.24	247.80
0- 7½	7.69	3.5426	259.34	0.84	3.63	262.97
0- 7¾	7.95	3.7480	274.37	0.92	3.98	278.35
0- 8	8.21	3.8869	284.54	0.98	4.24	288.78
0- 8¼	8.46	4.0983	300.02	1.08	4.67	304.69
0- 8½	8.72	4.2411	310.47	1.14	4.93	315.40
0- 8¾	8.97	4.4582	326.36	1.23	5.32	331.68
0- 9	9.23	4.6035	337.07	1.30	5.62	342.69
0- 9¼	9.49	4.8270	353.36	1.40	6.05	359.41
0- 9½	9.74	4.9769	364.33	1.46	6.31	370.64
0- 9¾	10.00	5.2040	380.96	1.58	6.83	387.79
0-10	10.26	5.4350	397.87	1.69	7.31	405.18
0-10¼	10.51	5.5902	409.23	1.77	7.65	416.88
0-10½	10.77	5.8258	426.48	1.89	8.17	423.65
0-10¾	11.03	5.9848	438.12	1.98	8.56	446.68
0-11	11.28	6.2255	455.74	2.11	9.13	464.87
0-11¼	11.54	6.3870	467.56	2.20	9.51	477.07
0-11½	11.79	6.6320	485.49	2.33	10.08	495.57
0-11¾	12.05	6.8795	503.61	2.48	10.73	514.34
1- 0	12.31	7.0460	515.80	2.59	11.20	527.00
1- 0¼	12.56	7.2990	534.32	2.70	11.68	546.00
1- 0½	12.82	7.4680	546.69	2.85	12.33	559.02
1- 0¾	13.08	7.7245	565.47	3.01	13.02	578.49
1- 1	13.33	7.8970	578.10	3.12	13.49	591.59
1- 1¼	13.59	8.1580	597.20	3.28	14.19	611.39
1- 1½	13.85	8.4210	616.46	3.44	14.88	631.34
1- 1¾	14.10	8.5975	629.38	3.56	15.40	644.78
1- 2	14.36	8.8645	648.92	3.74	16.17	665.09
1- 2¼	14.62	9.0440	662.06	3.87	16.74	678.80
1- 2½	14.87	9.3150	681.90	4.06	17.56	699.46
1- 2¾	15.13	9.498	695.23	4.18	18.08	713.31
1- 3	15.38	9.771	715.28	4.38	18.94	734.22
1- 3¼	15.64	9.956	728.83	4.50	19.46	748.29
1- 3½	15.90	10.234	749.18	4.70	20.33	769.51
1- 3¾	16.15	10.515	769.75	4.90	21.19	790.94
1- 4	16.41	10.703	783.51	5.03	21.75	805.26
1- 4¼	16.67	10.986	804.23	5.25	22.70	826.93
1- 4½	16.92	11.178	818.28	5.40	23.35	841.63
1- 4¾	17.18	11.465	839.29	5.63	24.35	863.64
1- 5	17.44	11.657	853.35	5.78	25.00	878.35
1- 5¼	17.69	11.949	874.72	6.02	26.03	900.75
1- 5½	17.95	12.240	896.03	6.25	27.03	923.06
1- 5¾	18.21	12.437	910.45	6.41	27.72	938.17
1- 6	18.46	12.732	932.04	6.64	28.72	960.76
1- 6¼	18.72	12.930	946.54	6.80	29.41	975.95
1- 6½	18.97	13.229	968.43	7.05	30.49	998.92
1- 6¾	19.23	13.429	983.07	7.21	31.18	1014.25
1- 7	19.49	13.731	1005.18	7.46	32.26	1037.44
1- 7¼	19.74	13.934	1020.04	7.63	33.00	1053.40
1- 7½	20.00	14.238	1042.29	7.90	34.17	1076.46
1- 7¾	20.26	14.547	1064.91	8.19	35.42	1100.33
1- 8	20.51	14.751	1079.84	8.38	36.24	1116.08
1- 8¼	20.75	15.060	1102.46	8.63	37.32	1139.78
1- 8½	21.03	15.267	1117.62	8.81	38.10	1155.72
1- 8¾	21.28	15.579	1140.46	9.06	39.18	1179.64
1- 9	21.54	15.787	1155.68	9.24	39.96	1195.64
1- 9¼	21.79	16.101	1178.67	9.54	41.26	1219.93
1- 9½	22.05	16.418	1201.88	9.84	42.56	1244.44
1- 9¾	22.31	16.630	1217.40	10.03	43.38	1260.78
1-10	22.56	16.944	1240.75	10.32	44.63	1285.38
1-10¼	22.82	17.161	1256.27	10.52	45.50	1301.77
1-10½	23.08	17.483	1279.84	10.82	46.79	1326.63
1-10¾	23.33	17.698	1295.58	11.04	47.74	1343.32
1-11	23.59	18.022	1319.30	11.36	49.13	1368.43
1-11¼	23.85	18.348	1343.16	11.69	50.56	1393.72
1-11½	24.10	18.566	1359.12	11.90	51.46	1410.58
1-11¾	24.36	18.892	1382.99	12.22	52.85	1438.84
2- 0	24.62	19.110	1398.94	12.43	53.76	1452.70
2- 0¼	24.87	19.440	1423.10	12.77	55.23	1478.33
2- 0½	25.13	19.662	1439.35	12.95	56.00	1495.35
2- 0¾	25.38	19.995	1463.73	13.29	57.48	1521.21
2- 1	25.64	20.217	1479.98	13.51	58.43	1538.41
2- 1¼	25.90	20.550	1504.36	13.87	59.98	1564.34
2- 1½	26.16	20.886	1528.96	14.22	61.50	1590.46
1- 1¾	26.41	21.110	1545.35	14.46	62.54	1607.89
2- 2	26.67	21.447	1570.02	14.82	64.09	1634.11
2- 2¼	26.92	21.672	1586.49	15.06	65.13	1651.62
2- 2½	27.18	22.111	1611.31	15.43	66.73	1678.04
2- 2¾	27.44	22.239	1628.00	15.68	67.81	1695.81
2- 3	27.69	22.581	1653.04	16.04	69.37	1722.41
2- 3¼	27.95	22.923	1678.07	16.40	70.93	1749.00
2- 3½	28.21	23.152	1694.84	16.65	72.01	1766.85
2- 3¾	28.46	23.494	1719.87	17.02	73.61	1793.48
2- 4	28.72	23.728	1737.00	17.27	74.69	1811.67
2- 4¼	28.97	24.072	1762.19	17.51	75.73	1837.92
2- 4½	29.23	24.302	1779.02	17.89	77.37	1856.39
2- 4¾	29.49	24.651	1804.57	18.27	79.01	1883.58
2- 5	29.75	25.000	1830.12	18.66	80.70	1910.82
2- 5¼	30.00	25.233	1847.18	18.93	81.87	1929.05
2- 5½	30.26	25.584	1872.87	19.32	83.55	1956.42
2- 5¾	30.51	25.818	1890.00	19.55	84.55	1974.55
2- 6	30.77	26.170	1915.77	19.94	86.23	2002.00
2- 6¼	31.03	26.407	1933.12	20.37	88.09	2021.21
2- 6½	31.28	26.760	1958.96	20.67	89.39	2048.35
2- 6¾	31.54	26.996	1976.24	20.97	90.69	2066.93
2- 7	31.79	27.351	2002.22	21.39	92.51	2094.73
2- 7¼	32.05	27.708	2028.36	21.79	94.24	2122.60
2- 7½	32.31	27.947	2045.78	22.07	95.45	2141.23
2- 7¾	32.56	28.302	2071.84	22.47	97.18	2167.02
2- 8	32.82	28.543	2089.48	22.74	98.34	2187.82
2- 8¼	33.08	28.899	2115.55	23.14	100.07	2215.62
2- 8½	33.33	29.140	2133.19	23.41	101.24	2234.43
2- 8¾	33.59	29.500	2159.54	23.84	103.10	2262.64
2- 9	33.85	29.860	2185.90	24.31	105.13	2291.03
2- 9¼	34.10	30.102	2203.61	24.59	106.34	2309.95
2- 9½	34.36	30.465	2230.18	25.00	108.12	2338.30
2- 9¾	34.62	30.708	2247.97	25.36	109.67	2357.64
2-10	34.87	31.071	2274.55	25.84	111.75	2386.30
2-10¼	35.13	31.314	2292.34	26.05	112.66	2405.00
2-10½	35.38	31.680	2319.13	26.50	114.60	2433.73
2-10¾	35.64	31.924	2336.99	26.80	115.90	2452.89
2-11	35.90	32.290	2363.78	27.25	117.85	2481.63
2-11¼	36.15	32.657	2390.65	27.70	119.79	2510.44
2-11½	36.41	32.902	2408.58	27.99	121.05	2529.63
2-11¾	36.67	33.269	2435.45	28.43	122.95	2558.40
3- 0	36.92	33.515	2453.46	28.75	124.34	2577.80
3- 0¼	37.18	33.885	2480.54	29.20	126.28	2606.82
3- 0½	37.44	34.131	2498.55	29.50	127.58	2626.13
3- 0¾	37.69	34.501	2525.64	29.95	129.52	2655.16
3- 1	37.95	34.873	2552.87	30.52	131.56	2684.43
3- 1¼	38.21	35.119	2570.88	30.74	132.94	2703.82
3- 1½	38.46	35.491	2598.11	31.25	135.15	2733.26
3- 1¾	38.72	35.739	2616.27	31.56	136.49	2752.76
3- 2	38.97	36.110	2643.43	32.02	138.48	2781.91
3- 2¼	39.23	36.359	2661.65	32.31	139.73	2801.38
3- 2½	39.49	36.732	2688.96	32.75	141.63	2830.59
3- 2¾	39.74	36.981	2707.19	33.06	142.97	2850.16
3- 3	40.00	37.355	2734.57	33.58	145.22	2879.79
3- 3¼	40.26	37.731	2762.09	34.05	147.26	2909.35
3- 3½	40.51	37.981	2780.39	34.35	148.55	2928.94
3- 3¾	40.77	38.355	2807.77	34.80	150.50	2958.27
3- 4	41.03	38.604	2826.00	35.10	151.80	2977.80
3- 4¼	41.28	38.982	2853.67	35.58	153.87	3007.54
3- 4½	41.54	39.233	2871.51	35.92	155.34	3026.65
3- 4¾	41.79	39.608	2899.50	36.39	157.38	3056.88
3- 5	42.05	39.862	2918.09	36.86	159.41	3077.50
3- 5¼	42.31	40.240	2945.76	37.18	160.79	3106.55
3- 5½	42.56	40.615	2973.21	37.67	162.91	3136.12
3- 5¾	42.82	40.869	2991.81	37.99	164.30	3156.11
3- 6	43.08	41.246	3019.41	38.49	166.46	3185.47
3- 6¼	43.33	41.499	3037.93	38.81	167.84	3205.77
3- 6½	43.59	41.876	3065.32	39.30	169.96	3235.48
3- 6¾	43.85	42.257	3093.42	39.78	172.04	3265.46
3- 7	44.10	42.510	3111.94	40.12	173.51	3285.45
3- 7¼	44.36	42.890	3139.75	40.62	175.67	3315.42
3- 7½	44.62	43.142	3158.20	40.95	177.10	3335.20
3- 7¾	44.87	43.521	3185.95	41.44	179.22	3365.17
3- 8	45.13	43.775	3204.54	41.77	180.64	3385.18
3- 8¼	45.38	44.155	3232.36	42.28	182.85	3415.21
3- 8½	45.64	44.409	3250.95	42.61	184.28	3435.23
3- 8¾	45.90	45.90	3278.84	43.09	186.35	3465.19
3- 9	46.15	45 171	3306.73	43.57	188.43	3495.16
3- 9¼	46.41	45.424	3325.25	43.89	189.81	3515.06
3- 9½	46.67	45.803	3353.00	44.38	191.93	3544.93
3- 9¾	46.92	46.058	3371.67	44.71	193.36	3565.03
3-10	47.18	46.438	3399.48	45.23	195.61	3595.09
3-10¼	47.44	46.693	3418.15	45.59	197.16	3615.31
3-10½	47.69	47.074	3446.04	46.12	199.46	3645.50
3-10¾	47.95	47.457	3474.08	46.63	201.66	3675.74
3-11	48.21	47.710	3492.60	46.96	203.09	3695.69
3-11¼	48.46	48.093	3520.64	47.46	205.25	3725.89
3-11½	48.72	48.348	3539.31	47.77	206.59	3745.90
3-11¾	48 97	48.729	3567.20	48.25	208.67	3775.87
4- 0	49.23	48.893	3585.79	48.59	210.14	3795.93
4- 0¼	49.49	49.366	3613.83	49.10	212.34	3826.17
4- 0½	49.74	49 621	3632.50	49.46	213.90	3846.40
4- 0¾	50.00	50 00	3660.24	50.00	216.24	3876.48
4- 1	...	...	...	...	...	3906.56
4- 1¼	...	...	...	...	...	3926.79
4- 1½	...	...	...	...	...	3957.03
4- 1¾	...	...	...	...	...	3977.09
4- 2	...	...	...	...	...	4007.06
4- 2¼	...	...	...	...	...	4027.07
4- 2½	...	...	...	...	...	4057.27
4- 2¾	...	...	...	...	...	4077.22
4- 3	...	...	...	...	...	4107.46



Cycloversion

FOR SUPERIOR AVIATION BASE STOCK

This new catalytic process enables small or large refiners to make a superior base stock for aviation gasoline from cracked naphtha. Cycloversion effects an unusually complete conversion to aromatic hydrocarbons in the gasoline boiling range and has the further advantage of being very efficient; that is, the by-products are largely valuable alkylating agents and high octane motor fuels.

ECONOMICAL CONVERSION OF PRESENT PLANTS

Present thermal cracking units can be used for Cycloversion with the addition of catalyst chambers and catalyst reactivating equipment. Cycloversion units can be designed to fit either small or large plants. Because Cycloversion is extremely flexible, a refinery so equipped can use a wide variety of charging stocks and can produce products in greatest demand at any particular time.

PROCESSES ★ ENGINEERING
PERCO
RESEARCH ★ CONSTRUCTION

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PHILLIPS PETROLEUM COMPANY, *Bartlesville, Oklahoma*

culator up to half way and add each one to the cylindrical section capacities for entry in the total gal. column.

The next and last step in the procedure of completing the table is easier to work than it is to explain. Assume that the tank is half full. The additional amount that must be put in to raise the depth ¼ in. will be the difference between the half-full gauge and the next ¼ in. below. Add this difference then to the midpoint gauge and you have the total for ¼ in. above midpoint. The remainder of the job is simply one of adding the differences backward to the last sum set down.

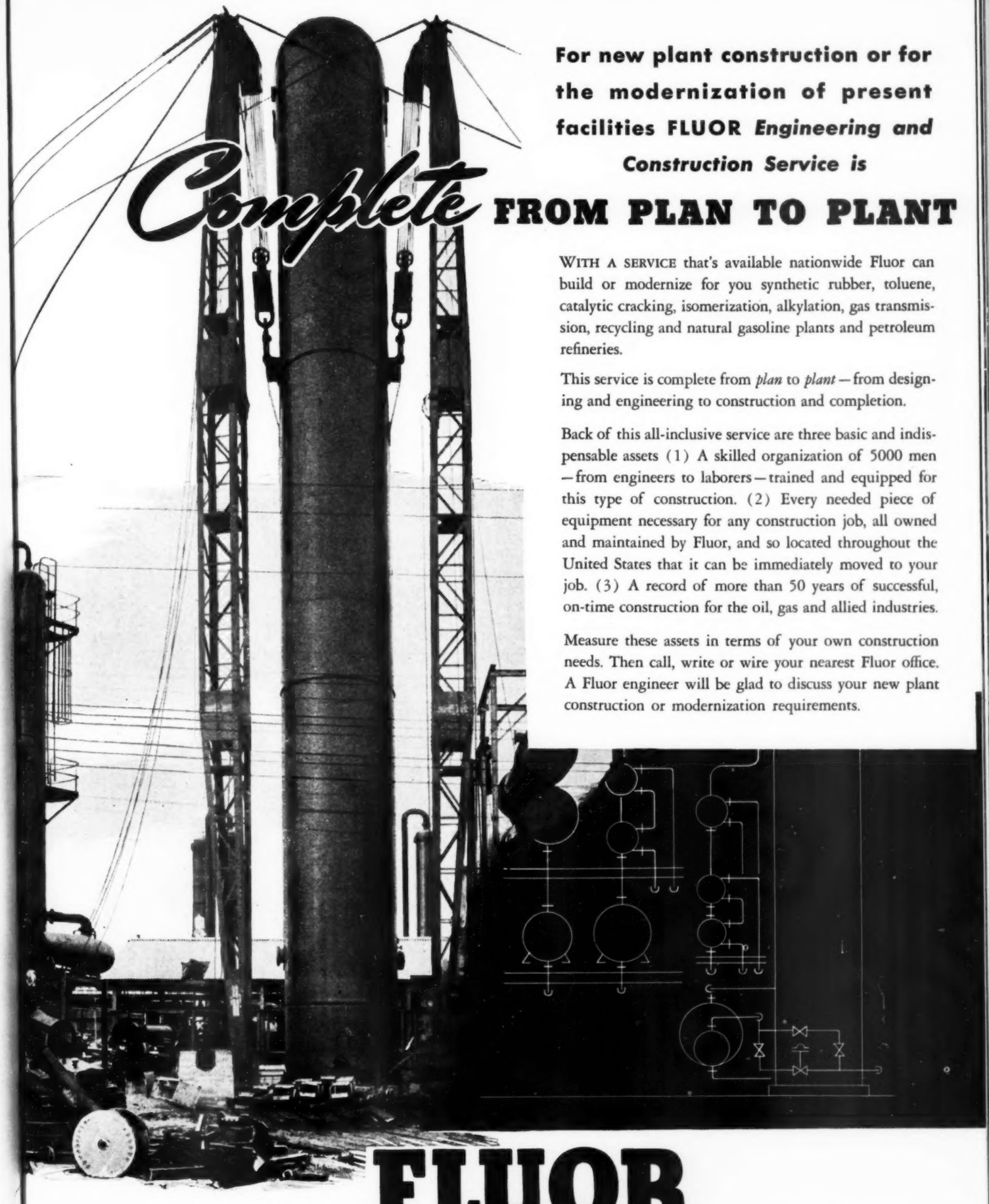
Finally, do not become too much concerned because your totals do not seem to progress quite so uniformly as they should. To make them entirely uniform would require that many more decimal points be used in calculating the percentages of d and c and few refinery operators require such a degree of accuracy in gauging their operating tanks of small size.

(Tables 2 and 3 on Page 92)

TABLE 1—Continued

Gauge	Cylindrical portion			Bumped ends		Total
Ft. In.	% d	% c	Gal.	% c	Gal.	gal.
4- 3¼	...	...	...	...	...	4137.65
4- 3½	...	...	...	...	...	4157.87
4- 3¾	...	...	...	...	...	4187.93
4- 4	...	...	...	...	...	4208 03
4- 4¼	...	...	...	...	...	4237.90
4- 4½	...	...	...	...	...	4257.80
4- 4¾	...	...	...	...	...	4287.77
4- 5	...	...	...	...	...	4317.73
4- 5¼	...	...	...	...	...	4337.75
4- 5½	...	...	...	...	...	4367.78
4- 5¾	...	...	...	...	...	4387.79
4- 6	...	...	...	...	...	4417.66
4- 6¼	...	...	...	...	...	4437.54
4- 6½	...	...	...	...	...	4467.51
4- 6¾	...	...	...	...	...	4487.50
4- 7	...	...	...	...	...	4517.48
4- 7¼	...	...	...	...	...	4547.19
4- 7½	...	...	...	...	...	4567.09
4- 7¾	...	...	...	...	...	4596.85
4- 8	...	...	...	...	...	4616 84
4- 8¼	...	...	...	...	...	4646.41
4- 8½	...	...	...	...	...	4675.46
4- 8¾	...	...	...	...	...	4696.08
4- 9	...	...	...	...	...	4726.31
4- 9¼	...	...	...	...	...	4745.42
4- 9½	...	...	...	...	...	4775.16
4- 9¾	...	...	...	...	...	4794.69
4-10	...	...	...	...	...	4824.02
4-10¼	...	...	...	...	...	4843.61
4-10½	...	...	...	...	...	4673.17
4-10¾	...	...	...	...	...	4902.80
4-11	...	...	...	...	...	4922.37
4-11¼	...	...	...	...	...	4951.58
4-11½	...	...	...	...	...	4971.05
4-11¾	...	...	...	...	...	5000.20
5- 0	...	...	...	...	...	5019.70
5- 0¼	...	...	...	...	...	5049.14
5- 0½	...	...	...	...	...	5068.53
5- 0¾	...	...	...	...	...	5097.80
5- 1	...	...	...	...	...	5126.83
5- 1¼	...	...	...	...	...	5146.14
5- 1½	...	...	...	...	...	5175.16
5- 1¾	...	...	...	...	...	5194.56
5- 2	...	...	...	...	...	5223.33
5- 2¼	...	...	...	...	...	5242.52
5- 2½	...	...	...	...	...	5271.33
5- 2¾	...	...	...	...	...	5300.07
5- 3	...	...	...	...	...	5319.23
5- 3¼	...	...	...	...	...	5347.96
5- 3½	...	...	...	...	...	5366.66
5- 3¾	...	...	...	...	...	5395.32
5- 4	...	...	...	...	...	5414.66
5- 4¼	...	...	...	...	...	5443.01
5- 4½	...	...	...	...	...	5461.93
5- 4¾	...	...	...	...	...	5490.32
5- 5	...	...	...	...	...	5518.53
5- 5¼	...	...	...	...	...	5537.54
5- 5½	...	...	...	...	...	5565.14
5- 5¾	...	...	...	...	...	5583.94
5- 6	...	...	...	...	...	5611.73
5- 6¼	...	...	...	...	...	5630.36
5- 6½	...	...	...	...	...	5658.23
5- 6¾	...	...	...	...	...	5686.03
5- 7	...	...	...	...	...	5704.61
5- 7¼	...	...	...	...	...	5731.75
5- 7½	...	...	...	...	...	5750.96
5- 7¾	...	...	...	...	...	5778.41
5- 8	...	...	...	...	...	5796.54
5- 8¼	...	...	...	...	...	5823.91
5- 8½	...	...	...	...	...	5842.14
5- 8¾	...	...	...	...	...	5869.38
5- 9	...	...	...	...	...	5896.57
5- 9¼	...	...	...	...	...	5915.04
5- 9½	...	...	...	...	...	5941.29
5- 9¾	...	...	...	...	...	5959.48
5-10	...	...	...	...	...	5986.11
5-10¼	...	...	...	...	...	6002.96
5-10½	...	...	...	...	...	6030.55
5-10¾	...	...	...	...	...	6057.15
5-11	...	...	...	...	...	6074.92
5-11¼	...	...	...	...	...	6101.34
5-11½	...	...	...	...	...	6118.85
5-11¾	...	...	...	...	...	6145.07
6- 0	...	...	...	...	...	6162.50
6- 0¼	...	...	...	...	...	6188.62
6- 0½	...	...	...	...	...	6214.55
6- 0¾	...	...	...	...	...	6231.75
6- 1	...	...	...	...	...	6257.61
6- 1¼	...	...	...	...	...	6274.63
6- 1½	...	...	...	...	...	6300.26
6- 1¾	...	...	...	...	...	6325.89
6- 2	...	...	...	...	...	6342.75
6- 2¼	...	...	...	...	...	6368.01

Gauge	Cylindrical portion			Bumped ends		Total
Ft. In.	% d	% c	Gal.	% c	Gal.	gal.
6- 2½	...	...	...	...	...	6384.87
6- 2¾	...	...	...	...	...	6410.16
6- 3	...	...	...	...	...	6435.27
6- 3¼	...	...	...	...	...	6451.96
6- 3½	...	...	...	...	...	6476.82
6- 3¾	...	...	...	...	...	6493.21
6- 4	...	...	...	...	...	6517.81
6- 4½	...	...	...	...	...	6534.15
6- 4½	...	...	...	...	...	6557.31
6- 4¾	...	...	...	...	...	6573.31
6- 5	...	...	...	...	...	6597.23
6- 5¼	...	...	...	...	...	6613.17
6- 5½	...	...	...	...	...	6636.87
6- 5¾	...	...	...	...	...	6652.52
6- 6	...	...	...	...	...	6676.49
6- 6¼	...	...	...	...	...	6699.55
6- 6½	...	...	...	...	...	6715.51
6- 6¾	...	...	...	...	...	6738.70
6- 7	...	...	...	...	...	6754.03
6- 7¼	...	...	...	...	...	6777.00
6- 7½	...	...	...	...	...	6792.19
6- 7¾	...	...	...	...	...	6814.78
6- 8	...	...	...	...	...	6829.89
6- 8¼	...	...	...	...	...	6852.20
6- 8½	...	...	...	...	...	6874.60
6- 8¾	...	...	...	...	...	6889.31
6- 9	...	...	...	...	...	6911.32
6- 9¼	...	...	...	...	...	6926.02
6- 9½	...	...	...	...	...	6947.69
6- 9¾	...	...	...	...	...	6962.01
6-10	...	...	...	...	...	6983.44
6-10¼	...	...	...	...	...	7004.66
6-10½	...	...	...	...	...	7018.73
6-10¾	...	...	...	...	...	7039.64
6-11	...	...	...	...	...	7053.49
6-11¼	...	...	...	...	...	7074.15
6-11½	...	...	...	...	...	7087.06
6-11¾	...	...	...	...	...	7108.17
7- 0	...	...	...	...	...	7121.61
7- 0¼	...	...	...	...	...	7141.56
7- 0½	...	...	...	...	...	7161.36
7- 0¾	...	...	...	...	...	7174.46
7- 1	...	...	...	...	...	7193.93
7- 1¼	...	...	...	...	...	7206.95
7- 1½	...	...	...	...	...	7225.95
7- 1¾	...	...	...	...	...	7238.61
7- 2	...	...	...	...	...	7257.38
7- 2¼	...	...	...	...	...	7275.88
7- 2½	...	...	...	...	...	7288.08
7- 2¾	...	...	...	...	...	7306.27
7- 3	...	...	...	...	...	7318.30
7- 3¼	...	...	...	...	...	7336.07
7- 3½	...	...	...	...	...	7347.77
7- 3¾	...	...	...	...	...	7365.16
7- 4	...	...	...	...	...	7382.31
7- 4¼	...	...	...	...	...	7393.54
7- 4½	...	...	...	...	...	7410.76
7- 4¾	...	...	...	...	...	7421.27
7- 5	...	...	...	...	...	7437.55
7- 5¼	...	...	...	...	...	7448.26
7- 5½	...	...	...	...	...	7464.17
7- 5¾	...	...	...	...	...	7474.60
7- 6	...	...	...	...	...	7489.98
7- 6¼	...	...	...	...	...	7503.15
7- 6½	...	...	...	...	...	7515.06
7- 6¾	...	...	...	...	...	7529.64
7- 7	...	...	...	...	...	7539.20
7- 7¼	...	...	...	...	...	7553.31
7- 7½	...	...	...	...	...	7562.45
7- 7¾	...	...	...	...	...	7576.00
7- 8	...	...	...	...	...	7589.28
7- 8¼	...	...	...	...	...	7597.90
7- 8½	...	...	...	...	...	7614.73
7- 8¾	...	...	...	...	...	7618.93
7- 9	...	...	...	...	...	7631.10
7- 9¼	...	...	...	...	...	7638.90
7- 9½	...	...	...	...	...	7650.31
7- 9¾	...	...	...	...	...	7657.71
7-10	...	...	...	...	...	7668.46
7-10¼	...	...	...	...	...	7678.81
7-10½	...	...	...	...	...	7685.41
7-10¾	...	...	...	...	...	7694.96
7-11	...	...	...	...	...	7701.04
7-11¼	...	...	...	...	...	7709.58
7-11½	...	...	...	...	...	7716.42
7-11¾	...	...	...	...	...	7722.86
8- 0	...	...	...	...	...	7730.04
8- 0¼	...	...	...	...	...	7735.28
8- 0½	...	...	...	...	...	7739.79
8- 0¾	...	...	...	...	...	7744.77
8- 1	...	...	...	...	...	7748.44
8- 1¼	...	...	...	...	...	7751.34
8- 1½	...	...	...	...	...	7752.95



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SINCE 1909

TABLE 2

Table for gauging cylindrical tanks—horizontal

Cylindrical portion only

% d = percentage of total diameter of tank
% c = percentage of total capacity of tank

% d	% c	% d	% c	% d	% c	% d	% c	% d	% c
0.1	0.0053	5.1	1.9250	10.1	5.2805	15.1	9.497	20.1	14.341
0.2	0.0152	5.2	1.9814	10.2	5.3580	15.2	9.588	20.2	14.444
0.3	0.0279	5.3	2.0383	10.3	5.4350	15.3	9.679	20.3	14.547
0.4	0.0429	5.4	2.0956	10.4	5.5122	15.4	9.771	20.4	14.649
0.5	0.0600	5.5	2.1535	10.5	5.5902	15.5	9.863	20.5	14.751
0.6	0.0788	5.6	2.2116	10.6	5.6690	15.6	9.956	20.6	14.854
0.7	0.0992	5.7	2.2705	10.7	5.7472	15.7	10.048	20.7	14.957
0.8	0.1212	5.8	2.3297	10.8	5.8258	15.8	10.142	20.8	15.060
0.9	0.1445	5.9	2.3895	10.9	5.9050	15.9	10.234	20.9	15.163
1.0	0.1692	6.0	2.4497	11.0	5.9848	16.0	10.327	21.0	15.267
1.1	0.1952	6.1	2.5105	11.1	6.0645	16.1	10.422	21.1	15.371
1.2	0.2223	6.2	2.5715	11.2	6.1445	16.2	10.515	21.2	15.475
1.3	0.2508	6.3	2.6333	11.3	6.2255	16.3	10.609	21.3	15.579
1.4	0.2800	6.4	2.6952	11.4	6.3060	16.4	10.703	21.4	15.683
1.5	0.3104	6.5	2.7579	11.5	6.3870	16.5	10.797	21.5	15.787
1.6	0.3419	6.6	2.8211	11.6	6.4685	16.6	10.893	21.6	15.892
1.7	0.3744	6.7	2.8845	11.7	6.5500	16.7	10.986	21.7	15.998
1.8	0.4077	6.8	2.9483	11.8	6.6320	16.8	11.082	21.8	16.101
1.9	0.4421	6.9	3.0127	11.9	6.7145	16.9	11.178	21.9	16.206
2.0	0.4773	7.0	3.0771	12.0	6.7970	17.0	11.273	22.0	16.312
2.1	0.5134	7.1	3.1426	12.1	6.8795	17.1	11.369	22.1	16.418
2.2	0.5501	7.2	3.2082	12.2	6.9630	17.2	11.465	22.2	16.524
2.3	0.5881	7.3	3.2742	12.3	7.0460	17.3	11.561	22.3	16.630
2.4	0.6263	7.4	3.3408	12.4	7.1305	17.4	11.657	22.4	16.737
2.5	0.6660	7.5	3.4075	12.5	7.2145	17.5	11.754	22.5	16.842
2.6	0.7061	7.6	3.4749	12.6	7.2990	17.6	11.851	22.6	16.949
2.7	0.7470	7.7	3.5426	12.7	7.3830	17.7	11.949	22.7	17.055
2.8	0.7886	7.8	3.6106	12.8	7.4680	17.8	12.046	22.8	17.161
2.9	0.8310	7.9	3.6790	12.9	7.5540	17.9	12.143	22.9	17.269
3.0	0.8742	8.0	3.7480	13.0	7.6390	18.0	12.240	23.0	17.376
3.1	0.9179	8.1	3.8171	13.1	7.7245	18.1	12.338	23.1	17.483
3.2	0.9625	8.2	3.8869	13.2	7.8110	18.2	12.437	23.2	17.590
3.3	1.0075	8.3	3.9570	13.3	7.8970	18.3	12.535	23.3	17.698
3.4	1.0533	8.4	4.0276	13.4	7.9840	18.4	12.633	23.4	17.806
3.5	1.0998	8.5	4.0983	13.5	8.0710	18.5	12.732	23.5	17.913
3.6	1.1470	8.6	4.1696	13.6	8.1580	18.6	12.831	23.6	18.022
3.7	1.1947	8.7	4.2411	13.7	8.2450	18.7	12.930	23.7	18.130
3.8	1.2432	8.8	4.3131	13.8	8.3330	18.8	13.030	23.8	18.240
3.9	1.2921	8.9	4.3855	13.9	8.4210	18.9	13.130	23.9	18.348
4.0	1.3418	9.0	4.4582	14.0	8.5090	19.0	13.229	24.0	18.457
4.1	1.3920	9.1	4.5312	14.1	8.5975	19.1	13.329	24.1	18.566
4.2	1.4429	9.2	4.6045	14.2	8.6860	19.2	13.429	24.2	18.675
4.3	1.4941	9.3	4.6782	14.3	8.7755	19.3	13.529	24.3	18.784
4.4	1.5461	9.4	4.7525	14.4	8.8645	19.4	13.630	24.4	18.892
4.5	1.5986	9.5	4.8270	14.5	8.9545	19.5	13.731	24.5	19.010
4.6	1.6515	9.6	4.9015	14.6	9.0440	19.6	13.832	24.6	19.110
4.7	1.7052	9.7	4.9769	14.7	9.1345	19.7	13.934	24.7	19.220
4.8	1.7594	9.8	5.0523	14.8	9.2240	19.8	14.035	24.8	19.330
4.9	1.8142	9.9	5.1280	14.9	9.3150	19.9	14.146	24.9	19.440
5.0	1.8693	10.0	5.2040	15.0	9.4060	20.0	14.238	25.0	19.551
25.1	19.662	30.1	25.350	35.1	31.314	40.1	37.480	45.1	43.775
25.2	19.773	30.2	25.467	35.2	31.436	40.2	37.606	45.2	43.902
25.3	19.884	30.3	25.584	35.3	31.558	40.3	37.731	45.3	44.028
25.4	19.995	30.4	25.701	35.4	31.680	40.4	37.856	45.4	44.155
25.5	20.106	30.5	25.818	35.5	31.802	40.5	37.981	45.5	44.282
25.6	20.217	30.6	25.935	35.6	31.924	40.6	38.106	45.6	44.409
25.7	20.328	30.7	26.052	35.7	32.046	40.7	38.231	45.7	44.538
25.8	20.439	30.8	26.170	35.8	32.168	40.8	38.355	45.8	44.663
25.9	20.550	30.9	26.288	35.9	32.290	40.9	38.479	45.9	44.790
26.0	20.661	31.0	26.407	36.0	32.412	41.0	38.604	46.0	44.918
26.1	20.773	31.1	26.524	36.1	32.534	41.1	38.730	46.1	45.043
26.2	20.886	31.2	26.642	36.2	32.657	41.2	38.856	46.2	45.171
26.3	20.998	31.3	26.760	36.3	32.780	41.3	38.982	46.3	45.298
26.4	21.110	31.4	26.878	36.4	32.902	41.4	39.108	46.4	45.424
26.5	21.222	31.5	26.996	36.5	33.025	41.5	39.233	46.5	45.550
26.6	21.334	31.6	27.114	36.6	33.147	41.6	39.358	46.6	45.678
26.7	21.447	31.7	27.232	36.7	33.269	41.7	39.482	46.7	45.803
26.8	21.560	31.8	27.351	36.8	33.392	41.8	39.608	46.8	45.930
26.9	21.672	31.9	27.470	36.9	33.515	41.9	39.735	46.9	46.058
27.0	21.785	32.0	27.589	37.0	33.638	42.0	39.862	47.0	46.183
27.1	21.898	32.1	27.708	37.1	33.762	42.1	39.988	47.1	46.311
27.2	22.011	32.2	27.827	37.2	33.885	42.2	40.114	47.2	46.438
27.3	22.125	32.3	27.946	37.3	34.008	42.3	40.240	47.3	46.565
27.4	22.239	32.4	28.065	37.4	34.131	42.4	40.365	47.4	46.693
27.5	22.353	32.5	28.184	37.5	34.254	42.5	40.490	47.5	46.819
27.6	22.467	32.6	28.302	37.6	34.377	42.6	40.615	47.6	46.947
27.7	22.581	32.7	28.422	37.7	34.501	42.7	40.741	47.7	47.074
27.8	22.695	32.8	28.543	37.8	34.625	42.8	40.869	47.8	47.201
27.9	22.810	32.9	28.660	37.9	34.749	42.9	40.994	47.9	47.329
28.0	22.923	33.0	28.781	38.0	34.873	43.0	41.120	48.0	47.457
28.1	23.038	33.1	28.899	38.1	34.996	43.1	41.246	48.1	47.583
28.2	23.152	33.2	29.020	38.2	35.119	43.2	41.372	48.2	47.710
28.3	23.266	33.3	29.140	38.3	35.242	43.3	41.499	48.3	47.837
28.4	23.380	33.4	29.260	38.4	35.368	43.4	41.628	48.4	47.965
28.5	23.494	33.5	29.380	38.5	25.941	43.5	41.749	48.5	48.093
28.6	23.611	33.6	29.500	38.6	35.615	43.6	41.876	48.6	48.220
28.7	23.728	33.7	29.620	38.7	35.739	43.7	42.002	48.7	48.348
28.8	23.842	33.8	29.740	38.8	35.865	43.8	42.129	48.8	48.475
28.9	23.957	33.9	29.860	38.9	35.988	43.9	42.257	48.9	48.603
29.0	24.072	34.0	29.981	39.0	36.110	44.0	42.383	49.0	48.729
29.1	24.187	34.1	30.102	39.1	36.234	44.1	42.510	49.1	48.857
29.2	24.302	34.2	30.223	39.2	36.359	44.2	42.637	49.2	48.983
29.3	24.418	34.3	30.344	39.3	36.483	44.3	42.762	49.3	49.112
29.4	24.535	34.4	30.465	39.4	36.608	44.4	42.890	49.4	49.239
29.5	24.651	34.5	30.587	39.5	36.732	44.5	43.018	49.5	49.366
29.6	24.769	34.6	30.708	39.6	36.856	44.6	43.142	49.6	49.494
29.7	24.884	34.7	30.829	39.7	36.981	44.7	43.268	49.7	49.621
29.8	25.000	34.8	30.950	39.8	37.106	44.8	43.397	49.8	49.748
29.9	25.116	34.9	31.071	39.9	37.230	44.9	43.521	49.9	49.877
30.0	25.233	35.0	31.192	40.0	37.355	45.0	43.648	50.0	50.000

TABLE 3

Table for gauging bumped ends of horizontal cylindrical tanks

% d = percentage of total diameter of tank
% c = percentage of total contents of both bumped ends

% d	% c	% d	% c	% d	% c	% d	% c	% d	% c
0.1	0.00	5.1	0.32	10.1	1.62	15.1	4.18	20.1	7.99
0.2	0.00	5.2	0.34	10.2	1.66	15.2	4.24	20.2	8.09
0.3	0.00	5.3	0.36	10.3	1.69	15.3	4.31	20.3	8.19
0.4	0.00	5.4	0.38	10.4	1.73	15.4	4.38	20.4	8.28
0.5	0.01	5.5	0.40	10.5	1.77	15.5	4.44	20.5	8.38
0.6	0.01	5.6	0.41	10.6	1.81	15.6	4.50	20.6	8.46
0.7	0.01	5.7	0.43	10.7	1.85	15.7	4.57	20.7	8.54
0.8	0.01	5.8	0.45	10.8	1.89	15.8	4.63	20.8	8.63
0.9	0.01	5.9	0.47	10.9	1.94	15.9	4.70	20.9	8.72
1.0	0.01	6.0	0.49	11.0	1.98	16.0	4.77	21.0	8.81
1.1	0.01	6.1	0.50	11.1	2.03	16.1	4.83	21.1	8.89
1.2	0.01	6.2	0.52	11.2	2.07	16.2	4.90	21.2	8.97
1.3	0.01	6.3	0.53	11.3	2.11	16.3	4.96	21.3	9.06
1.4	0.02	6.4	0.54	11.4	2.15	16.4	5.03	21.4	9.15
1.5	0.02	6.5	0.56	11.5	2.20	16.5	5.10	21.5	9.24
1.6	0.02	6.6	0.58	11.6	2.24	16.6	5.17	21.6	9.34
1.7	0.02	6.7	0.60	11.7	2.29	16.7	5.25	21.7	9.44
1.8	0.02	6.8	0.62	11.8	2.33	16.8	5.32	21.8	9.54
1.9	0.02	6.9	0.64	11.9	2.38	16.9	5.40	21.9	9.64
2.0	0.02	7.0	0.66	12.0	2.43	17.0	5.48	22.0	9.74
2.1	0.03	7.1	0.68	12.1	2.48	17.1	5.55	22.1	9.84
2.2	0.03	7.2	0.70	12.2	2.54	17.2	5.63	22.2	9.93
2.3	0.04	7.3	0.73	12.3	2.59	17.3	5.71	22.3	10.03
2.4	0.04	7.4	0.75	12.4	2.65	17.4	5.78	22.4	10.12
2.5	0.05	7.5	0.78	12.5	2.70	17.5	5.86	22.5	10.22
2.6	0.05	7.6	0.81	12.6	2.75	17.6	5.94	22.6	10.32
2.7	0.06	7.7	0.84	12.7	2.80	17.7	6.02	22.7	10.42
2.8	0.06	7.8	0.87	12.8	2.85	17.8	6.10	22.8	10.52
2.9	0.07	7.9	0.90	12.9	2.90	17.9	6.17	22.9	10.62
3.0	0.07	8.0	0.92	13.0	2.95	18.0	6.25	23.0	10.72
3.1	0.08	8.1	0.95	13.1	3.01	18.1	6.33	23.1	10.82
3.2	0.08	8.2	0.98	13.2	3.06	18.2	6.41	23.2	10.93
3.3	0.09	8.3	1.01	13.3	3.12	18.3	6.49	23.3	11.04
3.4	0.10	8.4	1.05	13.4	3.17	18.4	6.57	23.4	11.14
3.5	0.11	8.5	1.08	13.5	3.22	18.5	6.64	23.5	11.25
3.6	0.12	8.6	1.11	13.6	3.28	18.6	6.72	23.6	11.36
3.7	0.13	8.7	1.14	13.7	3.33	18.7	6.80	23.7	11.47
3.8	0.14	8.8	1.17	13.8	3.39	18.8	6.88	23.8	11.58
3.9	0.15	8.9	1.20	13.9	3.44	18.9	6.96	23.9	11.69
4.0	0.16	9.0	1.23	14.0	3.50	19.0	7.05	24.0	11.80
4.1	0.17	9.1	1.26	14.1	3.56	19.1	7.13	24.1	11.90
4.2	0.18	9.2	1.30	14.2	3.62	19.2	7.21	24.2	12.01
4.3	0.19	9.3	1.33	14.3	3.68	19.3	7.29	24.3	12.12
4.4	0.20	9.4	1.36	14.4	3.74	19.4	7.37	24.4	12.22
4.5	0.21	9.5	1.40	14.5	3.80	19.5	7.46	24.5	12.32
4.6	0.22	9.6	1.43	14.6	3.87	19.6	7.55	24.6	12.43
4.7	0.24	9.7	1.46	14.7	3.93	19.7	7.63	24.7	12.54
4.8	0.26	9.8	1.50	14.8	4.00	19.8	7.72	24.8	12.66
4.9	0.28	9.9	1.54	14.9	4.06	19.9	7.81	24.9	12.77
5.0	0.30	10.0	1.58	15.0	4.12	20.0	7.90	25.0	12.89
25.1	12.95	30.1	19.06	35.1	26.05	40.1	33.74	45.1	41.77
25.2	13.06	30.2	19.19	35.2	26.20	40.2	33.90	45.2	41.94
25.3	13.17	30.3	19.32	35.3	26.35	40.3	34.05	45.3	42.11
25.4	13.29	30.4	19.43	35.4	26.50	40.4	34.20	45.4	42.28
25.5	13.40	30.5	19.55	35.5	26.65	40.5	34.35	45.5	42.45
25.6	13.51	30.6	19.68	35.6	26.80	40.6	34.50	45.6	42.61
25.7	13.63	30.7	19.81	35.7	26.95	40.7	24.65	45.7	42.77
25.8	13 75	30.8	19.94	35.8	27.10	40.8	34.80	45.8	42.93
25.9	13.87	30.9	20.07	35.9	27.25	40.9	34.95	45.9	43.09
26.0	13.98	31.0	20.22	36.0	27.40	41.0	35.10	46.0	43.25
26.1	14.10	31.1	20.37	36.1	27.55	41.1	35.26	46.1	43.41
26.2	14.22	31.2	20.52	36.2	27.70	41.2	35.42	46.2	43.57
26.3	14.34	51.3	20.67	36.3	27.84	41.3	35.58	46.3	43.73
26.4	14.46	31.4	20.82	36.4	27.99	41.4	35.75	46.4	43.89
26.5	14.58	31.5	20.97	36.5	28.13	41.5	35.92	46.5	44.05
26.6	14.70	31.6	21.11	36.6	28.28	41.6	36.08	46.6	44.22
26.7	14.82	31.7	21.25	36.7	28.43	41.7	36.24	46.7	44.38
26.8	14.94	31.8	21.39	36.8	28.59	41.8	36.39	46.8	44.54
26.9	15.06	31.9	21.52	36.9	28.75	41.9	36.55	46.9	44.71
27.0	15.19	32.0	21.65	37.0	28.90	42.0	36.70	47.0	44.88
27.1	15.31	32.1	21.79	37.1	29.05	42.1	36.86	47.1	45.05
27.2	15.43	32.2	21.93	37.2	29.20	42.2	37.02	47.2	45.23
27.3	15.56	32.3	22.07	37.3	29.35	42.3	37.18	47.3	45.31
27.4	15.68	32.4	22.20	37.4	29.50	42.4	37.34	47.4	45.59
27.5	15 80	32.5	22.34	37.5	29.65	42.5	37.50	47.5	45.77
27.6	15.92	32.6	22.47	37.6	29.80	42.6	37.67	47.6	45.95
27.7	16.04	32.7	22.60	37.7	29.95	42.7	37.83	47.7	46.12
27.8	16.16	32.8	22.74	37.8	30.10	42.8	37.99	47.8	46.29
27.9	16.28	32.9	22.87	37.9	30.26	42.9	38.16	47.9	46.46
28.0	16.40	33.0	23.00	38.0	30.42	43.0	38.32	48.0	46.63
28.1	16.53	33.1	23.14	38.1	30.58	43.1	38.49	48.1	46.80
28.2	16.65	33.2	23.28	38.2	30.74	43.2	38.65	48.2	46.96
28.3	16.77	33.3	23.41	38.3	30.91	43.3	38.81	48.3	47.13
28.4	16.90	33.4	23.55	38.4	31.08	43.4	38.97	48.4	47.30
28.5	17.02	33.5	23.69	38.5	31.25	43.5	39.13	48.5	47.46
28.6	17.14	33.6	23.84	38.6	31.40	43.6	39.30	48.6	47.62
28.7	17.27	33.7	23.99	38.7	31.56	43.7	39.46	48.7	47.77
28.8	17.39	33 8	24.15	38.8	31.72	43.8	39.62	48.8	47.93
28.9	17.51	33.9	24.31	38.9	31.87	43.9	39.78	48.9	48.09
29.0	17.63	34.0	24.45	39.0	32.02	44.0	39.95	49.0	48.25
29.1	17.76	34.1	24.59	39.1	32.16	44.1	40.12	49.1	48.42
29 2	17.89	34.2	24.74	39.2	32.31	44.2	40.29	49.2	48.59
29.3	18.02	34.3	24.89	39.3	32.46	44.3	40.46	49.3	48.76
29.4	18.15	34.4	25.05	39.4	32.60	44.4	40.62	49.4	48.93
29.5	18.27	34.5	25.20	39.5	32.75	44.5	40.79	49.5	49.10
29.6	18.40	34.6	25.36	39.6	32.91	44.6	40.95	49.6	49.28
29.7	18.53	34.7	25.52	39.7	33.06	44.7	41.11	49.7	49.46
29.8	18.66	34.8	25.68	39.8	33.32	44.8	41.27	49.8	49.64
29.9	18.80	34.9	25.84	39.9	33.45	44.9	41.44	49.9	49.82
30.0	18.93	35.0	25.90	40.0	33.58	45.0	41.60	50.0	50.00

Determining Optimum Production Rates

☆ **Increased allowables, resulting from war demand, focus attention on problem of efficient operation of wells**

by Charles H. Rankin

Consulting Engineer

THE problem of determining the optimum production rate for wells and leases is receiving universal attention as war demands bring about increased allowables.

Any conservation program is a compromise between two objectives. The objective of investors or operators is to obtain the greatest possible return in a minimum of time. The engineer's objective is to achieve the greatest ultimate recovery. Conservation dictates a path between these two objectives, which can be stated as aiming at the greatest possible economic return; to obtain the greatest possible number of barrels at the minimum cost in a period of time consistent with the economics of the problem.

During recent years the practice of proration has forced operators and owners of oil wells and leases to forego their objective and in some cases has satisfied the objectives of the conservationists. Increased allowables and a growing tendency to restrict allowables on the basis of gas-oil ratios have caused many operators, who heretofore had little reason to consider gas-oil ratios and the most effective use of reservoir pressures, to become aware of and acknowledge the importance of these factors.

Suggested Method

A method is suggested in this article for determining the optimum rate of production for a flowing well and a method of maintaining control over the producing rate is embodied herein.

Fig. 1 is a graph on which are shown the gas-oil ratios, the bottom-hole pressures, and the daily average production of three tracts. Tract "A" is a 280 acre lease having six wells, tract "B" is a 160 acre lease having four wells, and tract "C" is a 160 acre lease having three wells. All are in the same field, not more than two miles apart, produce from sand, and have been under the same proration allowance.

From a study of this figure certain conclusions may be drawn: (1) There is a distinct relationship between the rate of production and the bottom-hole pressure decline; (2) different leases, although located in the same field and producing from the same sand, do not have equal potential capacities to produce, and (3) there is a distinct relationship between the bottom-hole pressure drop and the gas-oil ratio, and both are functions of the cumulative production as well as the rate of production.

Under conditions now existing, which will continue and be accelerated as the rate of production in the United States increases, every operator should have available curves of this type in order that he may determine at what point it becomes inadvisable to meet an increase in allowable. Just why this point should be recognized and this conclusion reached is more clearly demonstrated in Fig. 2, a graph on which the bottom-hole pressures on the same three tracts have been plotted against the cumulative production. A study of these three curves makes it quite obvious that different tracts have different potential production and that the ultimate recovery is a function of the rate of withdrawal as well as the cumulative.

Engineers studying reserves in fields where proration has been in effect have come to accept this method of estimating potential reserves when other methods of plotting production curves fail to show trends from which reserves can be estimated. It is plain that if three leases having the same number of wells are allowed the same production they will have similar production curves regardless of their respective potentialities. When we plot the bottom-hole pressure drop from the same leases against their cumulative production, however, we note a dissimilarity that reflects their real potentialities. It should be borne in mind that all factors weighing against such a curve must be considered. The method of operation, the method of operation of offset tracts, and other circumstances affect these curves.

Just how much oil can be produced from a well after the bottom-hole pressure has declined to the point where the well will cease to flow is dependent upon other factors: The nature of the natural drive, if any, the location of the lease with respect to the areal extent of the field, and what may be done in the way of secondary recovery.

(Continued on Page 98)

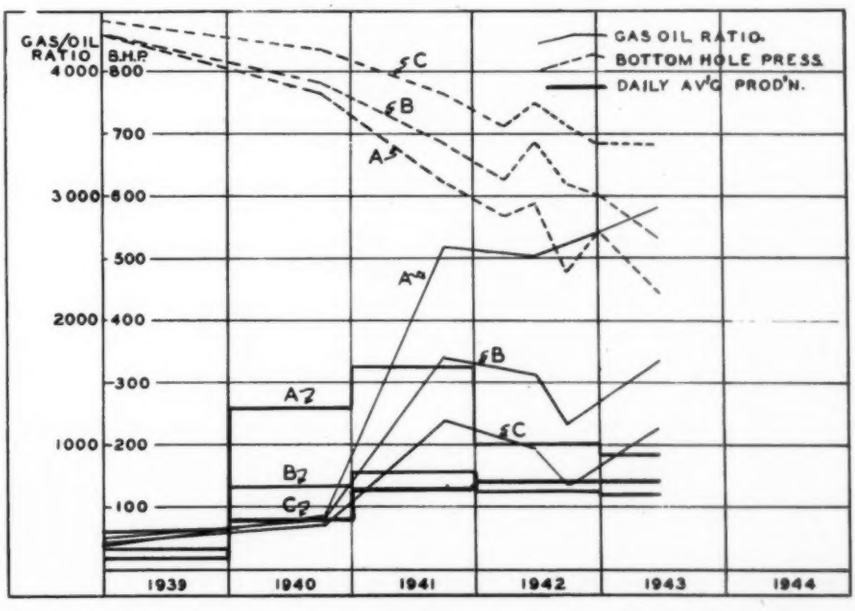

Fig. 1

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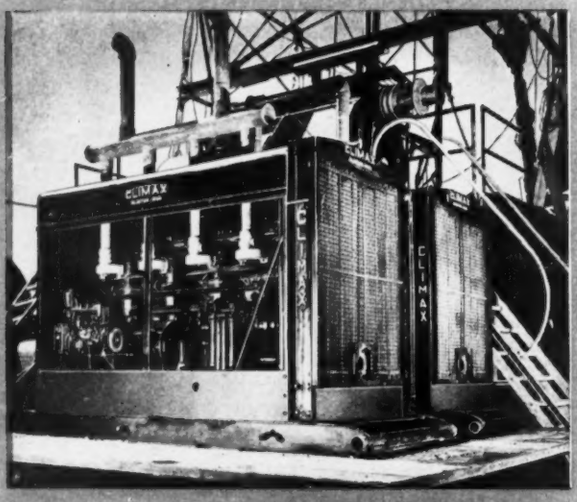

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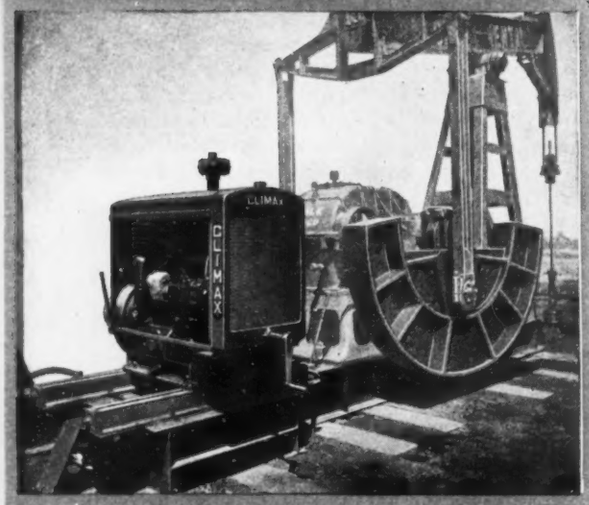
Recommended Engine Models

V-12, 12-cylinder, 60° "V" in 2 ratings, 390 hp. and 450 hp.; R225, 8-cylinder, 225 hp.; R6I, 6-cylinder, 150 hp.; R110, 4-cylinder, 110 hp.



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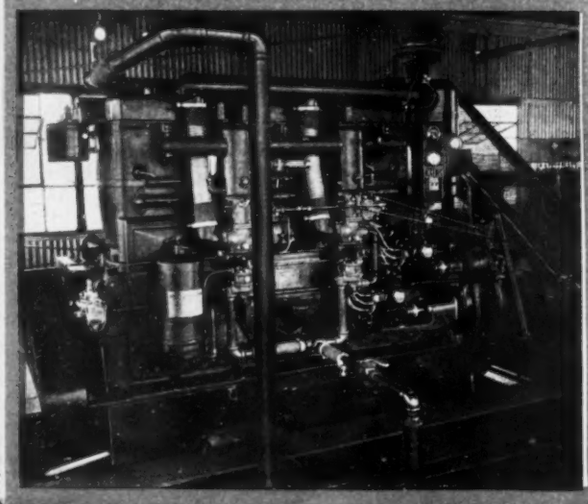
The close fuel regulation obtained with the venturi-type carburetor prevents flooding.

Recommended Engine Models

The Model N4B, 65 hp.; Models C, 4 and 6-cylinder, 7.5 to 45 hp.



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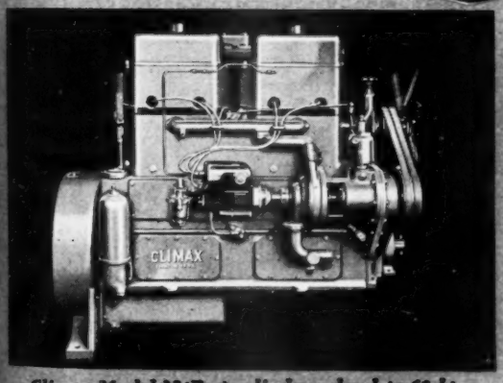
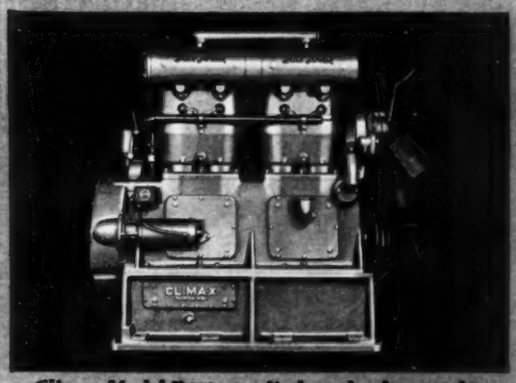
Recommended Engine Models

V12, 12-cylinder, 60° "V" in 2 ratings, 390 hp. and 450 hp.; R225, 8-cylinder, 225 hp.; R6I, 6-cylinder, 150 hp.; R110, 4-cylinder, 110 hp.

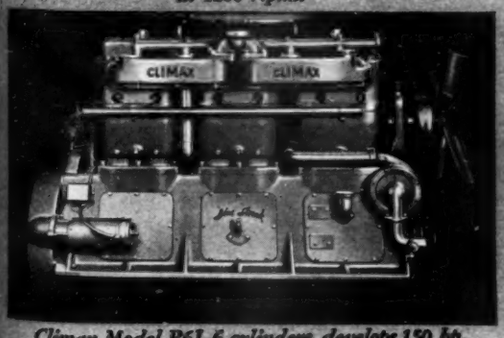
Climax V-12, 12 cylinders, 2 ratings, 225 hp. and 450 hp. at 1200 r.p.m.



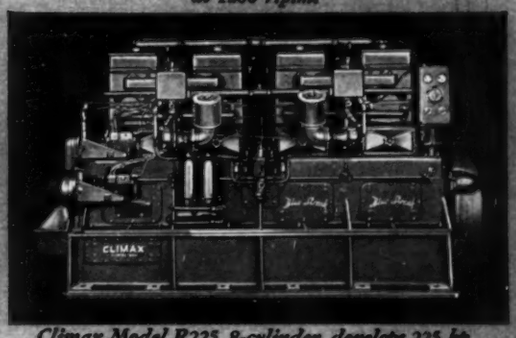
Climax Model N4B, 4 cylinders, develops 65 hp. at 1200 r.p.m.



Climax Model R110, 4 cylinders, develops 110 hp. at 1200 r.p.m.



Climax Model R6I, 6 cylinders, develops 150 hp. at 1200 r.p.m.



Climax Model R225, 8-cylinder, develops 225 hp. at 1200 r.p.m.

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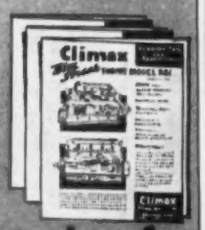

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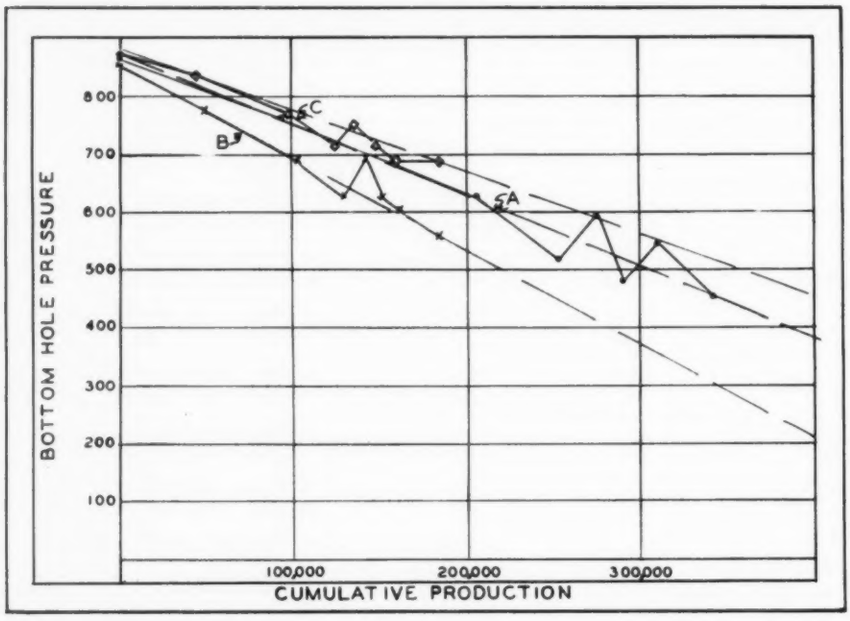


Fig. 2

(Continued from Page 95)

Studying the curves in Fig. 2, it again becomes obvious: (1) That there is a distinct relationship between bottom-hole pressure decline and the rate of production as well as the cumulative; (2) that different leases have different potentialities, and (3) that if the rate of bottom-hole pressure drop can be retarded the ultimate recovery and the amount of oil recoverable by flowing can be increased.

What Is Efficient Production?

This then is the key to the problem: How much oil can a lease produce efficiently? The study of a great number of such curves has demonstrated that in most cases when the bottom-hole pressure drop is retarded, the ultimate recovery can be increased, also that in most cases, lowering the rate of withdrawal will tend to reduce the rate at which the bottom-hole pressure declines.

The problem then becomes one of determining how much the rate of production can be retarded economically. Other factors necessarily must influence the solution of this problem. If the tract in question is operated as a single unit there are certain fixed charges that cannot be reduced, wages, taxes, interest, etc. If the rate of production is reduced the cost per barrel necessarily must increase. As labor is usually one of the largest items in the lifting cost statement, ways and means of reducing this item should be investigated. Many operators are finding that by pooling their operations they have been able to effect savings in labor costs as well as other items.

There is a growing tendency to consider means of obtaining adjustment of tax rates to some sort of equity, and as this item becomes of increasing importance these efforts will probably receive greater attention.

In preparing the charts used in illustrating this article only lease figures have been used. Better results can be achieved by studying the producing characteristics of the individual wells in the same manner and as conditions become more acute operators are giving greater attention to these studies.

The growing trend toward the use of gas-oil ratios as a basis for fixing allowables is focusing attention on means of controlling and reducing ratios. The study of a great many individual well test and lease histories has shown that gas-oil ratios can be kept at a minimum by maintaining careful control on the production methods. Wells should be tested at frequent, regular intervals and these tests should be plotted so that they can be compared with previous tests. Some operators have made the mistake of arriving at false conclusions from the results of a short series of tests. It has often been found that the gas-oil ratio of a flowing well will decline from day to day when the well is produced at a high rate and this method of production has been adopted. As a matter of fact, if the tests were continued over a longer period of time and gas-oil ratio considered with the bottom-hole pressure drop a different conclusion would be reached.

The curves shown in Fig. 1 are a reflection of this condition, although if the histories of these leases were unknown the evidence would escape attention. Tract "A," which shows the higher gas-oil ratio and bottom-hole pressure drop, has been produced by the method mentioned. The wells are opened for several days and produced at a high rate. Tract "B" has been operated in such a manner that a smaller amount of oil has been taken each day. The result is that over a long period of time this lease has shown a lower bottom-hole pressure drop and a better gas-oil ratio.

Engineering is achieving results that increasingly justify the small expenditures necessary to obtain and maintain effective control over producing operations. From the standpoint of the amount of money invested and the value of properties involved the oil industry has lagged far behind other industries in utilizing the assistance and abilities of its engineers. The trend is now toward their increased utilization and as a result of their efforts we find that it is now possible to increase the reserves in many fields from the estimates made when reservoir pressures and natural forces were not being utilized to their greatest extent.

——— ☆ ☆ ☆ ———

Point of View

"Known United States petroleum reserves, at present consumption rates, will last only 12 to 15 years whereas British reserves, at present consumption, will last 100 years. Despite this the United States is supplying 80 percent of the petroleum for Allied mechanized warfare, against 8 percent supplied from British sources."

—Senator Ralph O. Brewster.

"The truth is that American and British oil resources have been employed jointly from the beginning of hostilities. It is true that the use of Middle Eastern oil was restricted somewhat during the period when the Mediterranean was unsafe for tankers and when our Allied tanker fleet was dangerously inadequate."

—Deputy Petroleum Administrator Ralph K. Davies.

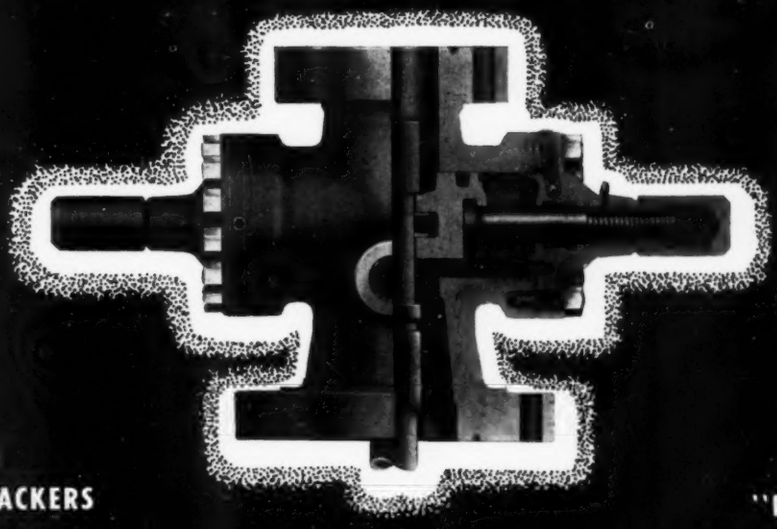
"Great Britain carefully watches out for its own oil resources and I suggest the United States should do likewise. American wells have supplied 75 to 80 percent of the oil used up to recently by the United Nations, while the American reserves constitute only 35 to 38 percent of the known world deposits."

—Senator Clarence J. Brown.

Key to Successful

DUAL COMPLETIONS

CAMERON RAM-TYPE TUBING CONTROL HEADS



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To date, three successful methods of dual completion have been perfected with Cameron equipment —Cameron Ram-Type Tubing Control Heads and Circulating Anchor Packers. (A Cameron Cross-Over Type Packer has been developed for use in conjunction with the standard type packer to divert flow from an upper sand through the tubing when desired.)

One method, the most widely adopted, utilizes a hanger nipple with back pressure valve type of tubing suspension on the closed rams of the control head (see illustration). A Cameron back-pressure valve removing tool and a completion service type blowout preventer are furnished to operators using this method. A second method, in which tubing is suspended from a threaded flange on top of the control head, permits working the wash pipe up and down to wash the face of both producing sands completely clean before packer is set. No auxiliary completion equipment is required; the Xmas tree master valve rather than a back-pressure valve, provides protection during washing operations. Still another method utilizes a hanger nipple with back pressure valve type suspension of the tubing on the closed rams of the control head and employs the Lewis Transfer Valve which automatically produces two sands intermittently.

With experience gained from approximately two hundred dual completions, Cameron is in a position to make valuable suggestions to operators contemplating multi-zone completion operations. A seasoned well completion operator will gladly bring complete details on all three Cameron dual completion methods to interested operators in areas where Cameron field service is provided. Other operators are invited to write for details.

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Shop Repair of Drawworks

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☆ Steel conservation and economic operation provided by shop repair and rebuilding

by C. C. Pryor
Associate Editor

THE present shortage of steel for the petroleum and other industries necessitates careful use and maintenance of equipment at all times. Equipment life must be extended far beyond past limits for the simple reason that much of it cannot be replaced without great difficulty. Thus the reconditioning and repairing of equipment in the petroleum industry has taken on new meaning.

Equipment playing a part in the production of oil and its products, whether refining, drilling, producing, or transporting, must be kept in efficient operating condition to supply the oil necessary for successful prosecution of the war. New steel is required for the casing and tubing of oil and gas wells. If the well is successfully completed as a producer, the steel in the casing and tubing is therefore not recoverable during the life of the well, and then may not be in condition to permit re-use. Equipment used to drill the well, however, can be and is used on subsequent wells. The service that must be rendered by a drilling rig is highly important if the operator is to profit from its use. Economical operation requires that maintenance and repair costs be kept at a minimum.

One of the most important parts of the drilling rig is the drawworks. Although much of the equipment of a rig is stationary, the drawworks is in almost constant motion. Lubrication to a great extent reduces wear on bushings, bearings, shafts, clutches, sprockets, chains, packing, etc., but use of the drawworks over a period of time for the drilling of a number of wells results in serious wear and repair is necessary if the full value of the equipment is to be realized.

A major tool company operating in Houston, Texas, equipped for the repair of such heavy machinery for the oil and related industries, has instituted a schedule of checking, repairing, and reconditioning drawworks. Much of the work is illustrated in the photographs accompanying this article. When a drawworks is received in the shop for repair, it is checked by a representative of the tool company and the drilling company. Recommendations for the work to be done is agreed upon by both representatives. The drawworks is then dismantled and again both representatives inspect and check the parts for necessary repairs. Repairs may include some improvement on drawworks of several years previous design, rebuilding and replacing of parts, cleaning, and other similar work.

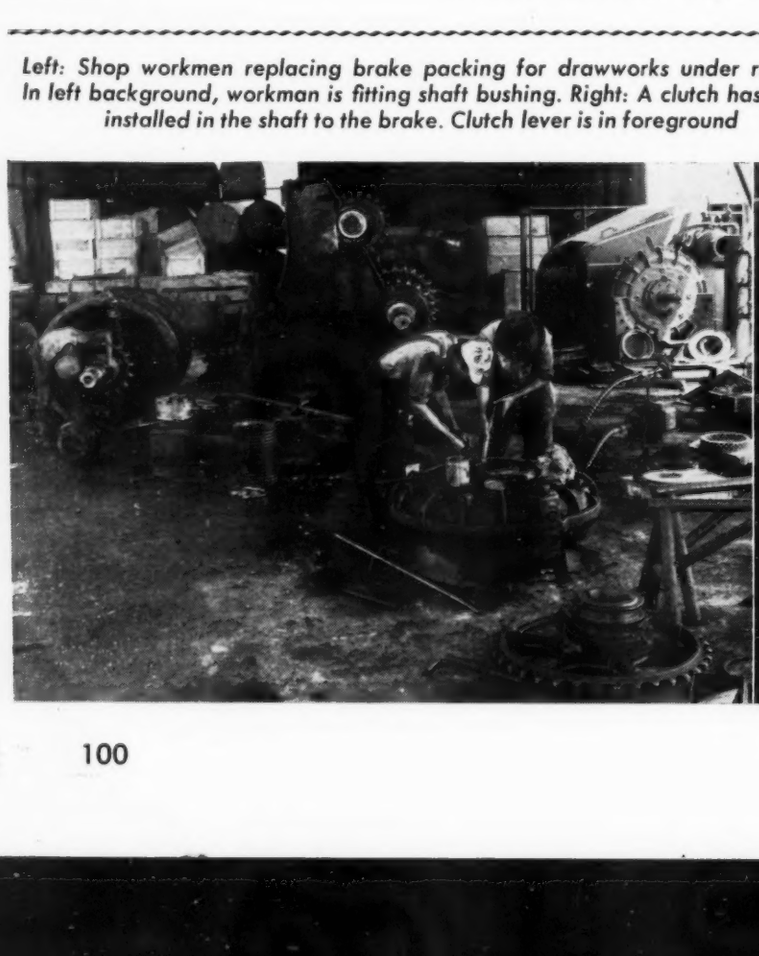
Sprockets

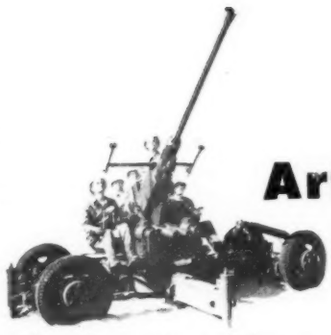
Sprockets on the shafts of the drawworks are subject to the greatest amount of wear. Teeth become badly worn and are not conducive to safe operation of the rig, and in addition increase the rate of wear on the chains transmitting power. The most economical method, keeping the repair cost and use of steel both low, is to machine off the old teeth and install a hardened sprocket rim. This cut is made just below the rim on which the teeth are cut. The rim is electrically welded on the wheel. These teeth are hardened by carburizing and are machined to fit the chain. To improve drawworks of several years previous design, double sprockets and oil bath prevent burning out chains on high-speed drives and provide greater power as well as long service.

Oilbath System

Some of the drawworks received at the shop for repairs do not have oilbath systems and as proper lubrication is one of the most important means for reducing wear, it is often advisable to

Left: Shop workmen replacing brake packing for drawworks under repair. In left background, workman is fitting shaft bushing. Right: A clutch has been installed in the shaft to the brake. Clutch lever is in foreground





Artillery . . . from Furnace to Front . . . Faster!

Centrifugal casting of heavy-caliber gun barrels, developed by the U. S. Army Ordnance Department, is typical of the revolutionary developments that are speeding war production.

The induction furnace, below, illustrates the first operating phase of this process. Here, alloy steel is reduced to a molten state and when ready for pouring, the entire furnace is transferred to the rotary casting machine where the molten steel is poured into a cylindrical mold. This mold, spinning at high speed, completely casts the gun barrel by centrifugal force in the short space of time required for molten metal to cool to a solid state.

The Hughes Tool Company, as operators of the Dickson Gun Plant, are proud of this addition to their Production for Victory . . . production which includes tools for the essential oil well drilling industry.

(Photos by U. S. Army Ordnance Dept.)

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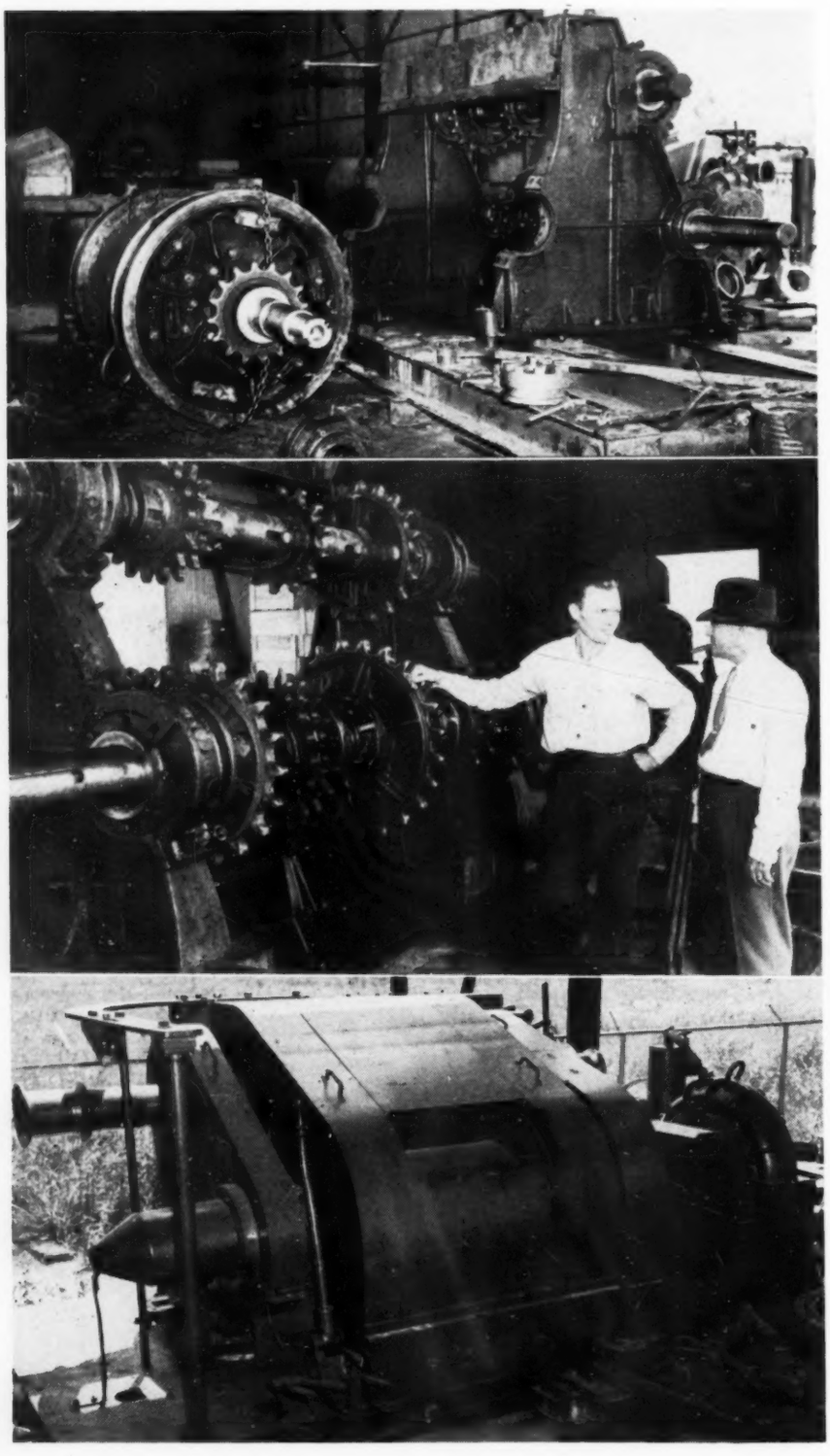
make such an installation on the drawworks while it is dismantled. Guards or oil-tight housings are built for the chains and sprockets and each guard has a spray from the circulating system that maintains a continuous bath of oil over all chains. The small pump is installed and driven from the jackshaft of the drawworks, which turns each time the engine turns.

Top: Dismantled drawworks simplifies repair work and permits close inspection of all parts. Center: Gilbert Rowe, plant superintendent, and U. V. Seale, secretary-treasurer of Hunt Tool Company, examine sprockets. Note new teeth on double sprocket in center of shaft and reinforcing plates on frame. Bottom: Repaired drawworks ready for service



Bushings and Bearings for Shafts

Worn bushings and bearings are replaced or repaired in the shop. Worn shafts are rebuilt by electric welding and then machined to the correct size. Crooked shafts are quickly and easily straightened by the shop hydraulic press. Worn out keyways are built up with welding metal and then re-milled.

Clutches and Brakes

The clutches on the drawworks are subjected to heavy shock and wear. These are carefully inspected in the shop and the necessary rebuilding and bushing done to repair them. Many brakes on drawworks are not water cooled, but by installing a water jacket and drilling a water course through the drumshaft to a stuffingbox on each end of the shaft, cooling by water circulation is effected.

As a part of the reconditioning and rebuilding required to bring drawworks design up to date, the hydromatic brake is moved farther out on the skids and connected to the shaft by a clutch. The clutch permits use of the brake when running a string of drill pipe in the hole and can be disengaged when coming out. It is also disengaged when raising empty blocks. Use of the clutch conserves power as the drag of the brake is released by the clutch when not required.

A drawworks grooved for one size wire line cannot be used for another size line. To increase the efficiency of the unit by using it for workover jobs and for drilling shallow and deep wells the line size must be changed. One drawworks sent to the shop for repairs was grooved for 1⅛-in. line. The grooves were machined off, diameter of the drum increased by welding ribs to the drum, and a new shell electrically welded over the ribs.

The drum of a drawworks must be balanced similar to the armature of a large generator or electric motor to eliminate excessive vibration and bearing wear. Such balancing is easily accomplished in the shop while the unit is dismantled. An unbalanced drum will cause intense vibration of the rig floor when going in or coming out of the hole and raising or lowering the empty blocks.

Moving a rig from location to location often results in broken or cracked skids. In repairing the skids it is often necessary to replace a complete section. The section is cut out and the replacing member electrically welded in. Cracked skids are electrically welded. The cracks are chipped out, the crack welded, and a reinforcing plate welded over the area.

Finally, the unit is carefully reassembled and tested, after which it is painted and delivered to the owner for service.

☆ ☆ ☆

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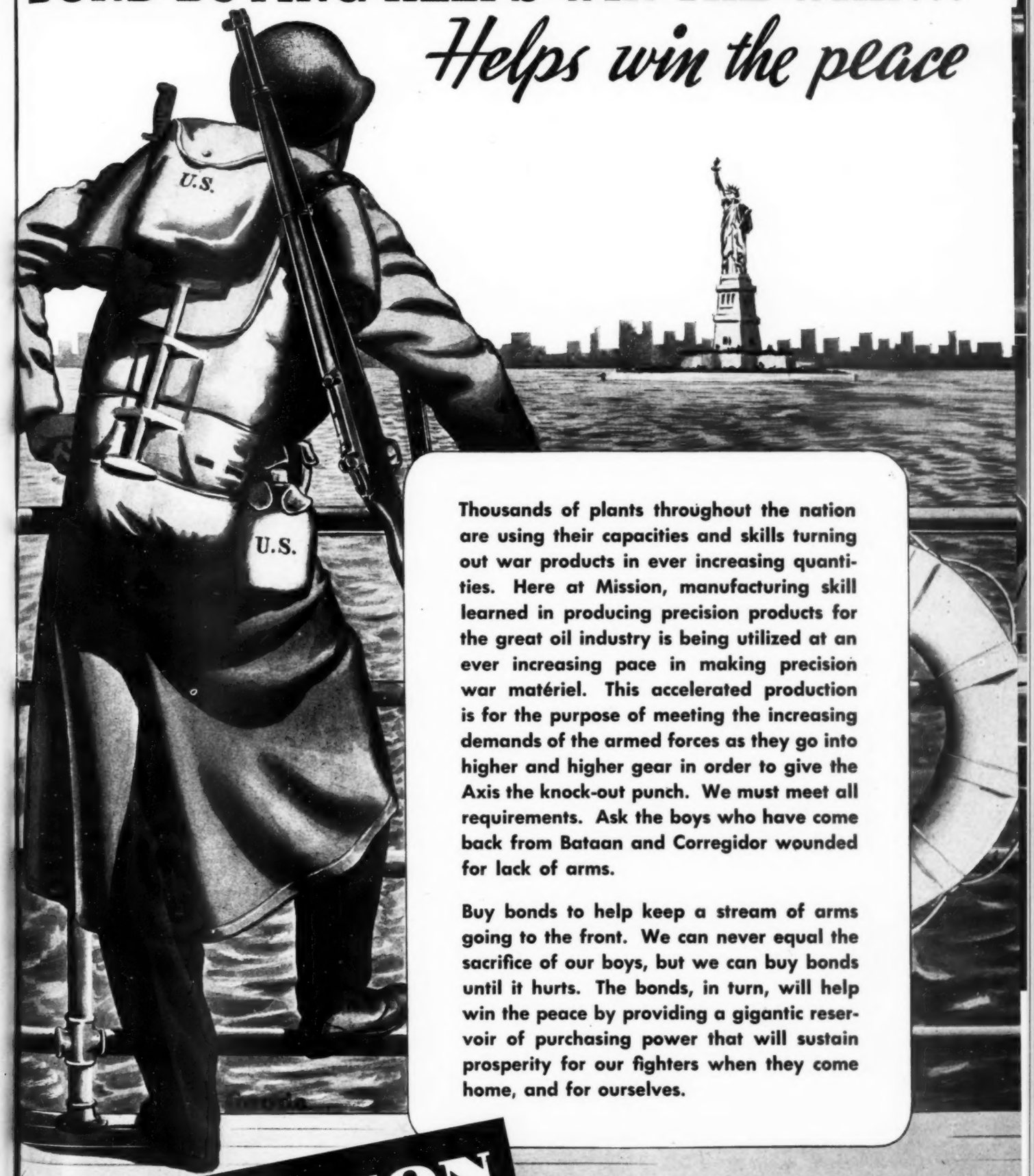
Helps win the peace



Thousands of plants throughout the nation are using their capacities and skills turning out war products in ever increasing quantities. Here at Mission, manufacturing skill learned in producing precision products for the great oil industry is being utilized at an ever increasing pace in making precision war matériel. This accelerated production is for the purpose of meeting the increasing demands of the armed forces as they go into higher and higher gear in order to give the Axis the knock-out punch. We must meet all requirements. Ask the boys who have come back from Bataan and Corregidor wounded for lack of arms.

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P 934.35

Many Venezuelans Are Educated in Oil Camps

☆ Children of workmen and workmen themselves are benefited by schools provided by oil companies

PETROLEUM ENGINEER Exclusive Feature

by Wallace A. Sawdon

Pacific Coast and Foreign Editor

A good part of the future Venezuelan nation is being educated today in the heart of petroleum operations.

In the rural school "Andres Bello S.O.V. No. 1," maintained by the Creole Petroleum Corporation at Caripito, useful citizens are in the making. Eight of them on the completion of the last school year entered on a special four-year preparatory course in the Caripito Refinery for practical professions within the petroleum refining branch.

The social work carried on in this school, together with the high level of education that has been achieved through the application of good pedagogic systems and careful selection of the teaching personnel, has resulted in a notable increase in the number of scholars. The number of those being educated in this school alone is 305 compared to 244 last year, or an increase of 25 percent.

Not only have the entrants increased but a great improvement has been accomplished in attendance. At the present time this is something more than 81 percent of the registration compared to 78.76 percent for the preceding scholastic year. Work has been carried on continuously in connection with the attendance of the pupils by sending the secretary of the school to the homes of the parents each time a child is absent in order to find out the cause. In such cases where persistent absence has been noted on the part of any student it is the grade teacher who visits the child's parents to study the problem personally.

The Standard Oil Company of Venezuela and the Lago Petroleum Corporation are carrying forward a program for the benefit of their workers and their children in the eastern and western sections of the country. This includes construction of modern schools, free medical attention for all pupils, night schools for workers, and agricultural training for children not yet old enough to work in industry.

School buildings are fully equipped with modern sanitary conveniences; garden plots and playgrounds are constantly going up on sites that preceding such development were overrun with dense forest growth.

In the towns where educational facilities are deemed inadequate, the companies have built schools for the children of their workers, such as the one in Guiria, in the state of Sucre, where most of the employees live in town.

One western Venezuelan state, Zulia, has four primary schools with 23 teachers and 1093 students. Built by the Lago Petroleum Corporation, the buildings are modern structures with large and airy classrooms and extensive playgrounds. As an example of the facilities and accommodations offered, two of the schools, "Concordia" of Cabimas and "Ayacucho" of Lagunillas are described.

Both schools cover an area of 9017 sq. ft. and have eight general classrooms capable of holding 50 students each. Each building has a large hall where theatrical shows are given by the students, in addition to other rooms for special studies. Libraries in the schools are for the use of the students and the general public. These libraries were started with donations of 300 books, which have been added to constantly.

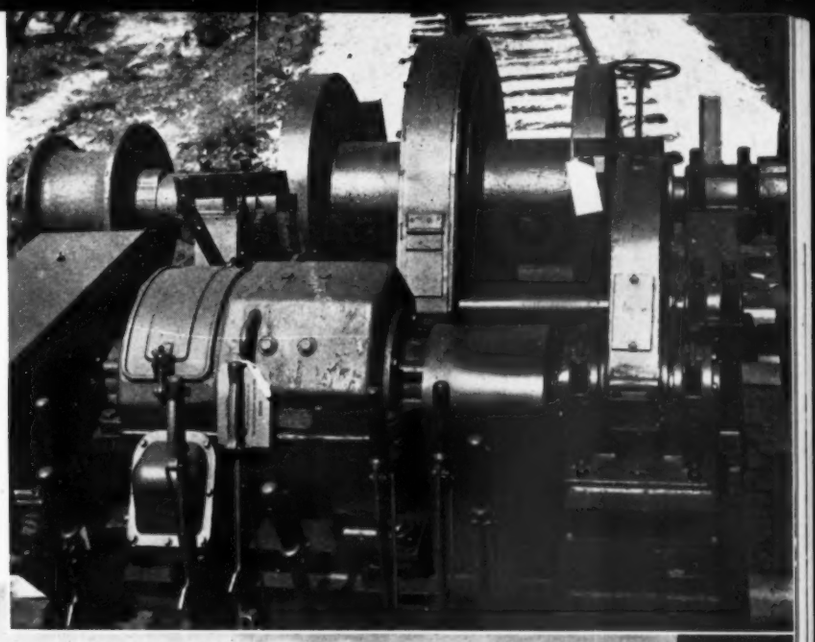
A large increase in the number of students attending "Concordia" required construction of an extra wing to the building. A feature of the new wing is a screen and equipment for picture shows.

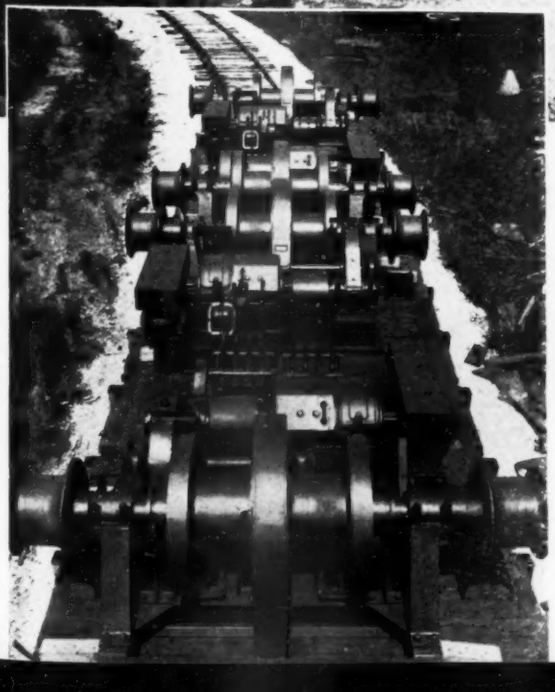
"Pueblo Nuevo," "El Pataiso," and "Miraflores," all situated in the Quiriquire district, were among the first schools established by Standard Oil of Venezuela. The "Pueblo Nuevo" school grew so rapidly that its provisional quarters soon were replaced by a specially constructed building and this had to be enlarged almost immediately to care for an increase in school children in the camp. "El Porvenir" at Caripito soon followed "Pueblo Nuevo" in its

Typical classroom, Escuela "Andrés Bello," Caripito

WINCHES FOR WAR

by **HUNT**





One of our jobs in this war is building fighting winches.... cargo and warping types.... electric and steam driven. By the carload they are being shipped regularly from our Houston plant. Through continuous expansion of our production facilities, our turnout of war materials has not curtailed our service to the Oil Industry. Nor shall it be curtailed, for ours is *a business built on service.... dependable service.... to the Oil Industry.*

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Class in tinsmithing

development. Growth of the camp was so rapid that the company found it necessary to construct an entirely new building.

The company sent a special delegate to Caracas to study the government rural school with a view to adapting for "El Porvenir" such improvements as were deemed advisable. When the school was opened its curriculum included agricultural training for children between the ages of 14 and 16 who have completed their primary education in the company's schools, but are not yet old enough to go to work in industry. A large plot of ground, fully equipped with modern agricultural tools for practical farm training, was purchased by the company for use by the class. The school has a classroom capacity of more than 400.

The company has opened new schools in its labor camp at the Temblador field, situated in the heart of the plains of south Monagas, and at Santa Rita labor camp in Cumarebo, state of Falcon, San Juaquin, and Jusepin.

Curriculums in these schools follow carefully the educational plans of the Venezuelan government, with which all schools are registered, and great care is exercised in selecting the teaching staff. To bring about greater cooperation between the home and school, parent-teacher associations have been formed and are lending efficient cooperation in the whole educational program.

Sports play a very important part in the company's educational program; students are supplied uniforms and equipment. All physical culture and recreational activities are supervised by special coaches appointed for the purpose.

Night schools organized for the benefit of the company's workers are well patronized. Ten night schools are being operated in the eastern Venezuela area alone and it has been necessary to increase the teaching staff to care for all who wish to take these courses. Another phase of the company's educational program is that of job training. Both Standard Oil of Venezuela and Lago Petroleum Corporation are carrying out an efficient plan of training their employees in all phases of the oil industry. Two groups are at present taking a course in electricity at Caripito, which includes instruction in interior electrical wiring, installation and maintenance of power lines, and installation and maintenance of electrical equipment and machinery. One group is receiving training under the direction of a special technical instructor, the other doing practical work for experience. Lago Petroleum Corporation is carrying out a similar program with courses in elementary and higher merchant marine studies and mechanics.

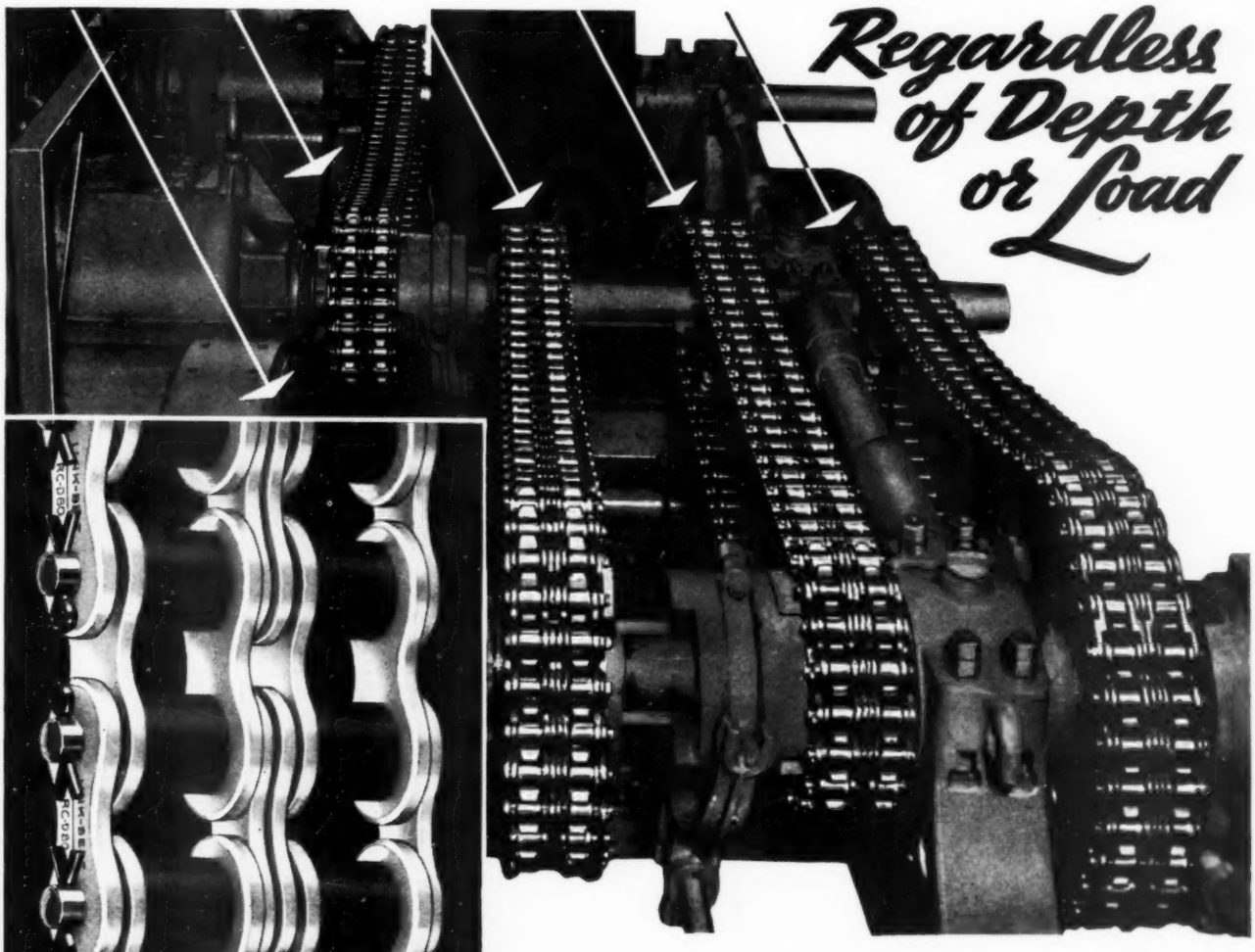
☆ ☆ ☆

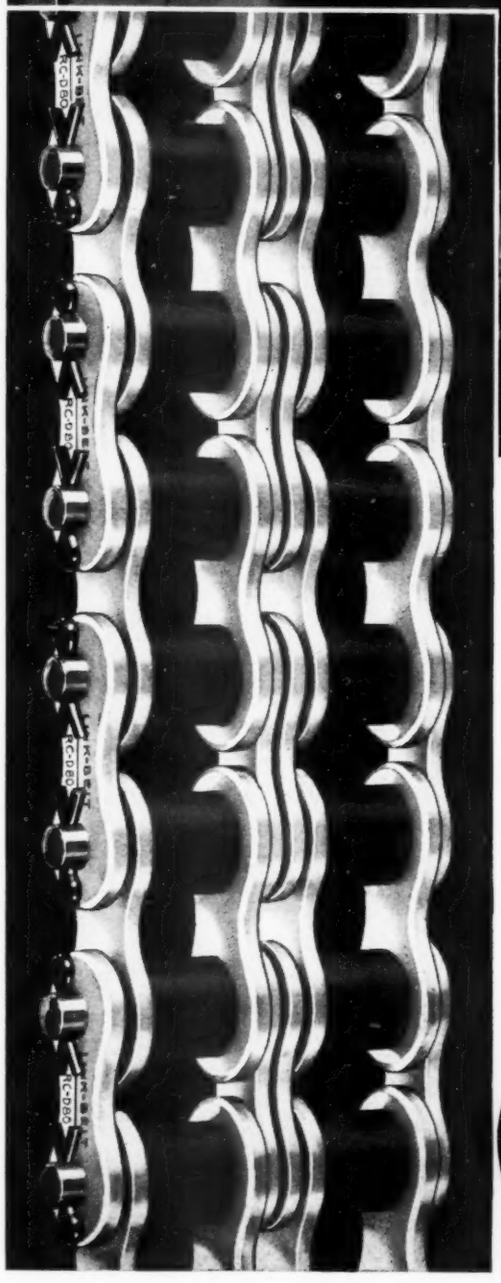
School children working in garden

Students being given agronomical instruction

Chained TO QUICKLY DRILL TO "PAY"

Regardless of Depth or Load





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Arranging Work Schedules for Natural Gasoline Plants

PETROLEUM ENGINEER Exclusive Feature

☆ Loss of manpower gives rise to problem of devising schedule for most efficient operation

by Don Attaway

Superintendent of Measurement, Arkansas Fuel Oil Company

THE loss of manpower in the natural gasoline industry has resulted in an extension of the work hours in many plants, and filling the time space once occupied by the missing man has necessitated changes in the work schedule that brings up puzzling problems regarding the type of plan or operating schedule best suited to the plant operation. At the same time, the new schedule must be equitable yet simple in order to prevent confusion and hardships on the employees.

A natural gasoline plant must remain in continuous operation. This means 168 hours of duty each week. The spacing and alloting of these hours to the personnel available often becomes a complex problem.

It may be assumed that most plants worked a 40-hour week in pre-war times and had adjusted their schedule so that each man worked his specified hours and had regular days off. In some plants, the initial loss of personnel to the military forces was the cause of extending the work week to 42 hours and for this type of week the Gray plan for a work schedule fits handily. Fig. 1 diagrams this work plan.

The advantages of this work schedule are many. Every man has at least five full 24-hour periods off each week. No relief man is required and every man has three out of four Sundays off. Every man also has some portion of the daytime off and thus obtains desirable sleeping time at nights. The plan also allows the supervisor to see the men at least every four days and reduces overtime to the theoretical minimum. Simply stated, the plan schedules a man to work eight hours, be off 24 hours, and repeats indefinitely without change. As there are no variations of the uniform pattern, the question arises: When does it start?

The diagram of the Gray plan indicates the calendar week beginning and ending with a man coming to work and one leaving. In most plants, the week does not begin on Sunday, nor do the shifts begin at noon, 8 p.m., and 4 a. m. This does not alter the working of the schedule as Monday can be substituted for the first day of the week and the shifts moved forward any given number of hours to give uniform arrangements.

Another 42-hour week schedule is diagramed in Fig. 2. Like the Gray plan it makes use of four men covering one operation, such as operators, firemen, or oilers. In this schedule one man works the same hours for five consecutive days, and every fourth week works one extra 8-hour day. Each man averages 42 hours per week and the rotation begins at the end of every sixth week. The daylight, evening, and morning tours are equally distributed and time-off periods balanced.

This schedule is valuable in case the constantly rotating of the Gray plan is objectional. Changing of shifts every five or six days might be preferred rather than a different shift each day.

It is assumed in the two schedules de-

(Continued on Page 112)

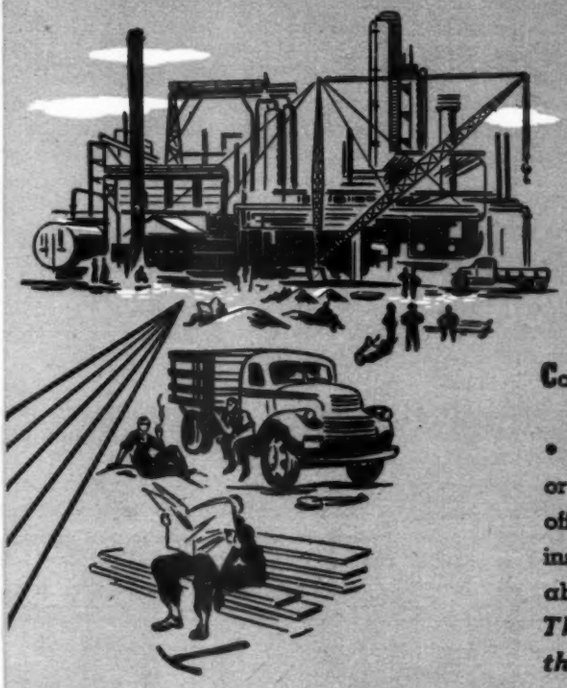
Fig. 1. Sample shift schedule of the Gray Plan—42-hour week program. This plan schedules a man to work 8 hours, be off 24 hours, and repeats indefinitely without change. Each man gets one overtime day every fourth week

		First week							Second week							Third week							Fourth week						
On	Off	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Noon	8 p.m.	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
8 p.m.	4 a.m.	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C
4 a.m.	Noon	C	D	A	B	C	D	A*	B	C	D	A	B	C	D*	A	B	C	D	A	B	C*	D	A	B	C	D	A	B*

*This shift represents the sixth or "overtime" shift in this particular arrangement, which each man has one week in four.

Fig. 2. A 42-hour week schedule. This plan rotates itself every six weeks. Off periods from 48 to 72 hours between shifts. Overtime weeks, time off periods, and tours equalized

	First week							Second week							Third week							Fourth week							Fifth week							Sixth week						
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
7 a.m.–3 p.m.	A	A	A	A	A	A	D	D	D	D	D	D	C	C	C	C	C	B	B	B	B	B	A	A	A	A	A	D	D	D	D	D	D	C	C	C	C	B	B	B	B
3p.m.–11p.m.	C	C	B	B	B	B	B	B	A	A	A	A	A	D	D	D	D	D	C	C	C	C	C	B	B	B	B	B	B	A	A	A	A	A	A	D	D	D	D	D	C	C
11p.m.–7a.m.	D	D	D	D	C	C	C	C	C	C	B	B	B	B	B	A	A	A	A	A	D	D	D	D	C	C	C	C	C	C	B	B	B	B	B	A	A	A	A	A	A	D
A—	48 hr.							40 hr.							40 hr.							40 hr.							48 hr.							40 hr.						
B—	40 hr.							40 hr.							40 hr.							48 hr.							40 hr.							40 hr.						
C—	40 hr.							40 hr.							48 hr.							40 hr.							40 hr.							40 hr.						
D—	40 hr.							48 hr.							40 hr.							40 hr.							40 hr.							48 hr.						



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(Continued from Page 108)

scribed that shifts rotate in most gasoline plants; however, some plants utilize what is known as a "swing shift." This type of operation allows the three regular crews to rotate but makes use of a "swing shift" that stands still and works the relief tours. Such a condition is shown in Fig. 3, which schedules a 44-hour week and rotates shifts at the end of every fourth week. Although such a condition is slightly unorthodox to gasoline plant operation, certain plants require such a schedule, and its preparation is quite puzzling when equality must be maintained.

The preparation of a 48-hour week schedule is relatively simple and no attempt will be made here to diagram such a plan; however, the conversion from a 48-hour week to a 52-hour week is somewhat involved and Fig. 4 outlines an actual work schedule now in operation in several plants.

This schedule makes use of the extra hours for plant repairs and maintenance. With the exception of the 4-hour extra duty, the schedule is the usual 48-hour week schedule, permitting the regular days off to remain the same. This plan utilizes three regular operators, three regular oilers or firemen, and one relief man, usually an operator. The schedules of operators and oilers are kept separate to indicate the movement of the relief man.

A feature of this schedule is the flexibility of rotation. The plan can be based on any number of weeks and then rotated. The rotation order must be clockwise. For example:

Operator's order of rotation: Day operator becomes relief man, relief man becomes evening operator, evening operator becomes night operator, and night operator becomes day operator.

Oiler's order of rotation: Day man becomes evening oiler, evening oiler becomes night oiler, and night oiler becomes day oiler.

Provided full use is made of the added 4 hours, this schedule adds greatly to plant efficiency by maintaining good operation and constant repair. As each man completes his 12-hour tour of duty, the following day he is off. In view of the fact that only one 12-hour shift is worked weekly, the schedule creates no hardships. All-night shifts are avoided and daylight work makes up the extra four hours.

A variation of the 52-hour week schedule is shown in Fig. 5. This schedule requires a break-shift week schedule for rotation. To permit days off, two days of the week are broken into 12-hour shifts. The rotating order is clockwise and the relief man spends five days of the week repairing, loading gasoline, testing, etc. His 12-hour day permits the regular operators a day off.

In plants having a regular crew of

Fig. 3. A 44-hour week schedule. This plan rotates the three regular crews and allows the "swing shift" to stand still. Operating crew makes its overtime day repairing. Swing shift does no repair work

First week							Second week							Third week							Fourth week						
M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
D	C	C	C	C	C	D	D	C	C	C	C	C	D	D	C	C	C	C	C	D	D	C	C	C	C	C	D
A	D	D	A	A	A	A	A	D	D	A	A	A	A	A	D	D	A	A	A	A	A	D	D	A	A	A	A
B	B	B	D	D	B	B	B	B	B	D	B	B	B	B	B	B	D	D	B	B	B	B	B	D	B	B	B
A—40 hr. C—48 hr.		B—40 hr. D—48 hr.		C crew repairs Sun.			A—48 hr. C—40 hr.		B—48 hr. D—40 hr.		A crew repairs Wed.			A—40 hr. C—48 hr.		B—40 hr. D—48 hr.		C crew repairs Sun.			A—48 hr. C—40 hr.		B—48 hr. D—40 hr.		A crew repairs Wed.		

Fifth week							Sixth week							Seventh week							Eighth week						
M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
D	A	A	A	A	A	D	D	A	A	A	A	A	D	D	A	A	A	A	A	D	D	A	A	A	A	A	D
B	D	D	B	B	B	B	B	D	D	B	B	B	B	B	D	D	B	B	B	B	B	D	D	B	B	B	B
C	C	C	D	D	C	C	C	C	C	D	C	C	C	C	C	C	D	D	C	C	C	C	C	D	C	C	C
A—48 hr. C—40 hr.		B—40 hr. D—48 hr.		A crew repairs Sun.			A—40 hr. C—48 hr.		B—48 hr. D—40 hr.		B crew repairs Wed.			A—48 hr. C—40 hr.		B—40 hr. D—48 hr.		A crew repairs Sun.			A—40 hr. C—48 hr.		B—48 hr. D—40 hr.		B crew repairs Wed.		

Ninth week							Tenth week							Eleventh week							Twelfth week						
M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
D	B	B	B	B	B	D	D	B	B	B	B	B	D	D	B	B	B	B	B	D	D	B	B	B	B	B	D
C	D	D	C	C	C	C	C	D	D	C	C	C	C	C	D	D	C	C	C	C	C	D	D	C	C	C	C
A	A	A	D	D	A	A	A	A	A	D	A	A	A	A	A	A	D	D	A	A	A	A	A	D	A	A	A
A—40 hr. C—40 hr.		B—48 hr. D—48 hr.		B crew repairs Sun.			A—48 hr. C—48 hr.		B—40 hr. D—40 hr.		C crew repairs Wed.			A—40 hr. C—40 hr.		B—48 hr. D—48 hr.		B crew repairs Sun.			A—48 hr. C—48 hr.		B—40 hr. D—40 hr.		C crew repairs Wed.		

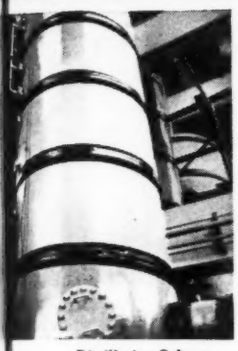
Fig. 4. A 52-hour week schedule. A plan for making use of the extra hours for maintenance. A operates on Sunday until 4 p. m. and then repairs from 4 p. m. to 8 p. m. He is off Sunday. B comes to work at noon on Wednesday and repairs until 4 p. m. at which time he takes his regular shift. He is off Thursday. C operates Friday night and remains on duty Saturday until noon doing repair work. He is off Sunday and returns to work at 12:01 a. m. Monday. D operates in the relief spot on Monday morning but remains for four hours that afternoon doing repair work. His day off is Sunday.

Operators	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8 a.m.– 4 p.m.	D	A	B—Repair 4 hr. A	A	A	C—Repair 4 hr. A	A
4 p.m.–12 m.	D—Repair 4 hr. B	B	B	D	B	B	A—Repair 4 hr. B
12 m.– 8 a.m.	C	C	C	C	C	D	C

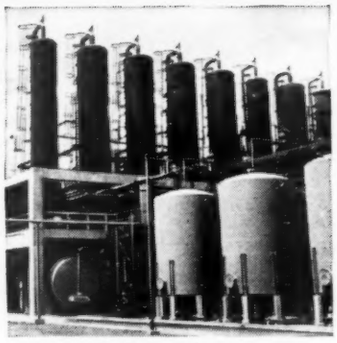
Firemen or oilers	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8 a.m.– 4 p.m.	X	Y—Repair 4 hr. D	X	X	Z—Repair 4 hr. X	X	X
4 p.m.–12 m.	X—Repair 4 hr. Y	Y	D	Y	Y	Y	Y
12 m.– 8 a.m.	Z	Z	Z	Z	D	Z	Z

TEN YEARS' WORK IN TWO

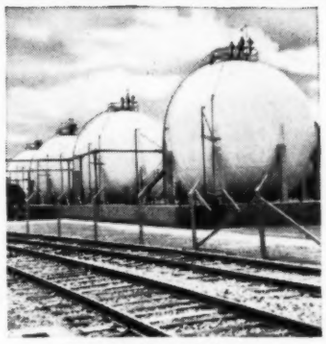
is the story behind Butadiene and Styrene for Synthetic Rubber



Distillation Column for Styrene



Where Distillation Columns separate and purify the Butadiene



Butadiene Storage Spheres

WE WISH YOU could see the first of the Government's large integrated synthetic rubber projects, complete at one location. What you see here is a night scene and some daytime views of the immense butadiene and styrene plants that CARBIDE AND CARBON CHEMICALS CORPORATION, a Unit of UCC, has designed and built at Institute, West Virginia, for the Government's Defense Plant Corporation and is operating for the Rubber Reserve Company.

Carbide and Carbon also has completed another butadiene plant at Louisville, Kentucky —and has released plans to Koppers United Company for a third butadiene plant near Pittsburgh, Pennsylvania.

Butadiene had never been manufactured in the United States in large quantities before the plants at Institute went into production. The task involved in providing the mass production facilities the Government asked for was an unusual one...but one that took full advantage of the experience and processes developed by Carbide and Carbon.

Generally, it requires seven to ten years for a company to take a process developed in the laboratory, put that process to test in a pilot plant, iron out production problems, design a full-size plant, and then actually build the plant and go into mass production.

By working at top speed for twenty months —Carbide and Carbon telescoped research, development, engineering, and construction work that would have taken 10 years in normal times. In this short time laboratory research was translated through chemical engineering into larger and more modern facilities for producing the chemicals for synthetic rubber than existed anywhere else in the world.

This achievement could never have been possible had it not been for the years of research and experimentation which, prior to the emergency, Carbide and Carbon had devoted to the production of synthetic—or man-made—chemicals of the organic series.

Business men, technicians, teachers, and others are invited to send for the book "Butadiene and Styrene for Buna S Synthetic Rubber from Grain Alcohol" which explains what these plants do, and what their place is in the Government's rubber program.

• • •

BUTADIENE, (bew-ta-dý-een). A highly volatile liquid which is the principal chemical in the manufacture of Buna synthetic rubbers.

STYRENE, (stý-reen). A liquid, like benzene, but having the property of reacting within itself to form a solid, clear, plastic mass. It is used as one of the principal ingredients of Buna S synthetic rubber.

BUY UNITED STATES WAR BONDS AND STAMPS

CONSTRUCTION RECORD AT INSTITUTE

June 25, 1941 — Carbide and Carbon submits definite production estimates.

July 31, 1941 — Design work starts on 10,000-ton-a-year butadiene unit.

Aug. 22, 1941 — Government authorizes construction.

Dec. 7, 1941 — Pearl Harbor

Dec. 15, 1941 — Design "frozen" for 20,000-ton-a-year alcohol-to-butadiene plant.

March, 1942 — Japanese occupy Malay Peninsula and Dutch East Indies; cut off about 90 per cent of U.S. natural rubber supply.

April, 1942 — Construction on the first of four 20,000-ton-a-year butadiene units starts at Institute, W. Va.

July, 1942 — Construction of 25,000-ton-a-year styrene plant starts.

Sept. 10, 1942 — Rubber Survey (Baruch) Committee report accepted.

Jan. 29, 1943 — First large-scale, alcohol-to-butadiene unit goes into operation two months ahead of schedule.

April 7, 1943 — First styrene unit begins operation.

May 25, 1943 — Fourth 20,000-ton-a-year butadiene unit begins operation at Institute plant.

August, 1943 — Four 20,000-ton-a-year butadiene units producing at rate of 120,000 tons a year—50% over rated capacity.

UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street UCC **New York 17, N. Y.**

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Haynes Stellite Company
United States Vanadium Corporation

CHEMICALS
Carbide and Carbon Chemicals Corporation

ELECTRODES, CARBONS & BATTERIES
National Carbon Company, Inc.

INDUSTRIAL GASES AND CARBIDE
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS: Bakelite Corporation • Plastics Division of Carbide and Carbon Chemicals Corporation

four operators and four firemen this schedule works for both. The relief fireman usually staggers his relief day to such time in the week that an operator and fireman will not be left alone on any 12-hour shift. On the other five days, the relief fireman repairs and washes boilers. Of course, separate schedules must be maintained.

In plants operating on a 56-hour week, the schedule of Fig. 6 works each man two 12-hour days and four 8-hour days each week. The off day falls on Sunday every third week. The schedule can be rotated every third week by having "A" return to work a 12-hour shift on the first day of the new week, in place of "B." This will automatically drop "B" into "C" position and pass "C" into "A" position and rotate the shift in a clockwise direction. Simple substitution reveals the new three-week schedule.

A variation of the 56-hour week is shown in Fig. 7 wherein off days are limited to Sundays, Wednesdays, and Saturdays, with each shift getting one out of three of these days. The schedule repeats every three weeks and can also be rotated in a manner similar to Fig. 6.

Often the extension of work time in a week solves the problem of a lost worker, but the adoption of a longer week requires the formation of a work schedule that will be equitable and at the same minimize overtime. Any schedule giving one man less that the 40-hours in any week usually increases the overtime to another. Care must be exercised, too, in avoiding a seventh consecutive day of work, which usually means double-time pay. Due consideration must be given to absenteeism, which requires emergency operators and firemen.

All these conditions aggravate the making of a schedule and the trial and error method of forming a work plan is long and tedious. Most of the schedules outlined in this article are flexible and can be extended or shortened in many cases. In plants now operating on similar schedules, a comparison will undoubtedly point out ways and means of solving personnel questions or even reduce overtime and "doubling-back" shifts.

Certain consideration, too, must be given to the beginning of work days. In many plants, the operating day begins at 8 a.m., whereas at others the operating day begins at midnight. The difference might appear on the schedule as a seventh day worked and be the basis of a double-time day. This condition, however, can be readily offset by moving the schedule forward or backward to fit the time element.

Good working schedules add greatly to the efficiency of a plant and contribute in a large measure to the reduction of accidents. Workers receiving a full eight hours sleep or more, suffer less from fatigue than men on short schedules and long hours. In numerous cases, present plant crews include many men advanced in years. New personnel for the most part could be called older men on whom the physical requirements of the job have been materially reduced in order to procure workers. This condition requires that work hours be so spaced that rest and recreation are ample. —— ☆ ☆ ☆ ——

Fig. 6. A 56-hour week schedule. A 3-week schedule that can be rotated to give each man two 12-hour days and four 8-hour days each week

First week

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8 a.m.– 4 p.m.	B	A	A	A	A	A	A
4 p.m.–12 m.	B/C	A/B	A/C	B	B	B	B
12 m.—8 a.m.	C	B	C	C	C	C	C

Second week

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8 a.m.– 4 p.m.	A	A	B	A	A	A	A
4 p.m.–12 m.	A/B	A/C	B/C	B	B	B	B
12 m.– 8 a.m.	B	C	C	C	C	C	C

Third week

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8 a.m.– 4 p.m.	A	B	A	A	A	A	A
4 p.m.–12 m.	A/C	B/C	A/B	B	B	B	B
12 m.– 8 a.m.	C	C	B	C	C	C	C

Fig. 7. A 56-hour week schedule. A variation of Fig. 6 in which days off are limited to Sundays, Wednesdays, and Saturdays

First week

		Sun.	Mon.	Tues.	Wed.		Thurs.	Fri.	Sat.	
7 a.m.– 3 p.m.	A Sun. off	B	A	A	A	B Wed. off	A	A	A	C Sat. off
3 p.m.–11 p.m.		B/C	B	B	A/C		B	B	A/B	
11 p.m.– 7 a.m.		C	C	C	C		C	C	B	

Second week

7 a.m.– 3 p.m.	B Sun. off	A	A	A	A	C Wed. off	A	A	B	A Sat. off
3 p.m.–11 p.m.		A/C	B	B	A/B		B	B	B/C	
11 p.m.– 7 a.m.		C	C	C	B		C	C	C	

Third week

7 a.m.– 3 p.m.	C Sun. off	A	A	A	B	A Wed. off	A	A	A	B Sat. off
3 p.m.—11 p.m.		A/B	B	B	B/C		B	B	A/C	
11 p.m.– 7 a.m.		B	C	C	C		C	C	C	

Fig. 5. A 52-hour week schedule. A variation of Fig. 4 in which the relief man operates one 12-hour shift during the week and makes his other 40 hours repairing, etc., during daylight hours. Schedule can be operated for any number of weeks and then rotated so that all men catch tours on different shifts

Regular week							Break-shift week							New regular week							Break-shift week						
M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
D	A	A	A	A	A	A	C	A	C	C	C	C	C	A	C	C	C	C	C	C	B	C	B	B	B	B	B
D/C	B	B	B	B	B	A/B	C/D	A/B	D	D	D	D	D	A/B	D	D	D	D	D	C/D	B/A	C/D	A	A	A	A	A
C	C	C	C	C	C	B	D	B	B	B	B	B	B	B	B	B	B	B	B	D	A	D	D	D	D	D	D

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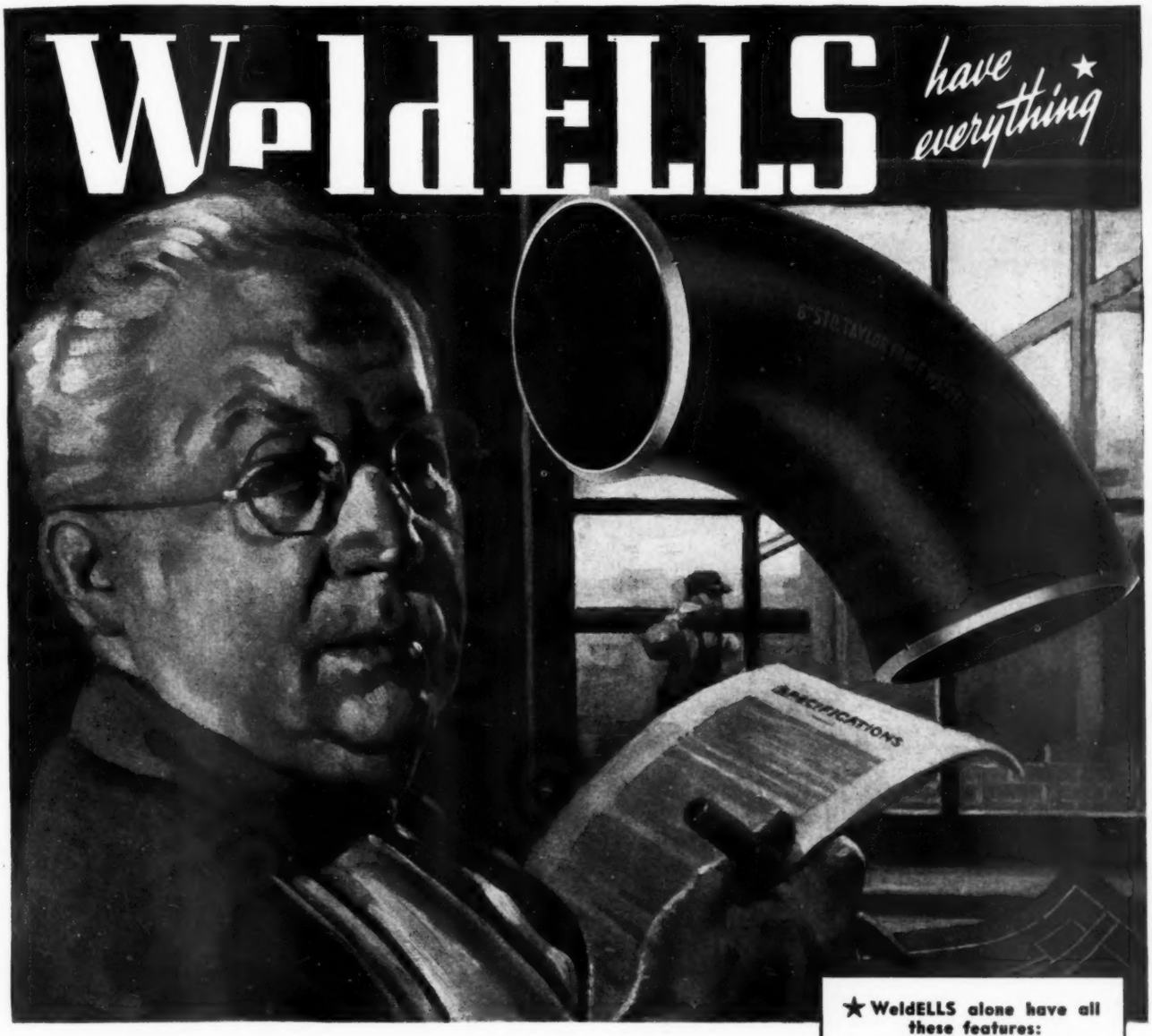

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Economic Considerations of the Well Spacing Problem

☆ Production cost, price of crude oil, and proration are among essential factors

PETROLEUM ENGINEER EXCLUSIVE Feature

by Lester C. Uren

Professor of Petroleum Engineering, University of California

WELL spacing has both physical and economical aspects. The principles of well spacing, concerned with the physical aspects of the problem, were discussed in the September issue of *The Petroleum Engineer*. The present discussion will review the more important economic factors. Oil fields are drilled not so much to produce oil as to earn profits, and considerations of cost and price, and the restrictions imposed by artificial systems of production control, will have their influence on the spacing of wells, as well as consideration of factors that influence recovery and drainage efficiency.

Maximum profit is realized in exploitation of an oil producing property when the summation of present values of the differentials between price of oil sold and cost of oil produced is a maximum. It is apparent that cost, price, time of production, the interest rate earned by capital, and the quantity of oil produced are factors in determining profit. These variables, except the interest rate, are influenced by the distance apart at which wells are spaced.[39*]

For each well drilled the operator gains a production unit and the greater the number of these production units the greater will be his facility of control of production. If a competitive situation exists, close spacing of wells on his property will enable the operator to obtain more of the production of the pool than his neighbors with wider spacing. If, on the other hand, operators are restricted in their right to produce by proration limitations or by cooperative or unit agreements that limit each operator's right to produce to the oil within his own land boundaries, then the operator with closely spaced wells will enjoy no advantage over his neighbors, but will nevertheless profit by better control of the rate of production from his own property. He may take his production more rapidly, if proration restrictions permit, than his neighbor with less closely spaced wells, and thus profit by earlier realization of values and reduction in interest charges on use of capital. Within limits, where gas expansion is the primary expulsive force operative, he may also expect to procure a larger percentage recovery of the available oil within his boundaries than would be possible with more widely spaced wells.[11]

Influence of production cost. The cost of producing a barrel of oil comprises items representing the cost of well drilling and intangible development expense; and operating cost, including the cost of well operation and maintenance, depreciation of plant, general and administrative expense, and depletion and/or royalty charges. Most of these items are markedly influenced by the rate of production of the wells which, in turn, is influenced by the well spacing. Wide spacing of wells generally results in a greater average per-well rate of production than close spacing.

A large part of the cost of field development is represented by the cost of drilling wells. Close spacing of wells results in high development cost and smaller profit unless the higher cost is offset by production of a greater quantity of oil or production in shorter time. A well must repay its capital cost and the cost of operation before it may earn profits; hence, the "pay-out" status of a well is an important consideration. A well must have drainage command of a sufficient volume of oil that can be produced at a cost and within an interval of time that will enable it to pay out. Close spacing of wells permits a more rapid recovery of the available oil and, within limits, greater overall recovery, both of which make for greater financial income. This greater income, however, may be more than offset by the increased cost of the closely-spaced wells. A balance must be sought between these opposing factors, and it would appear that there is some optimum number of wells that will yield maximum profit.

In appraising the production possibilities for a given tract, estimates of rates of recovery and ultimate recovery for different well spacings must be prepared. An allowance of 10 acres per well will perhaps promise a greater recovery per acre and would permit of more rapid recovery of the greater part of the producible oil than if 20-acre spacing were adopted. Perhaps the income thus realized would more than compensate for the increased drilling cost. Allowing only 5 acres per well might promise somewhat greater ultimate recovery and a more rapid rate of recovery than 10-acre spacing, but the percentage increase in income obtainable by 5-acre spacing over that possible by 10-acre spacing would be smaller than the advantage shown by 10-acre spacing over 20-acre spacing and perhaps would not justify the additional drilling expense. Thus, there is a point where diminishing increments in production do not compensate for the added cost of development.

In approaching the problem of determining how many wells he should drill on a given tract, the operator's primary objective will be to establish a spacing program that will confer a maximum present value on his property. Each well drilled will involve a certain capital expenditure that may be rather closely estimated. The cost of drilling, however, will not be directly proportional to the number of wells, for the cost per well is somewhat less by reason of reduction of "overhead" when supervision and other general expenses can be spread over a greater number of simultaneously drilled wells. The cost per well will increase with the depth to which drilling must be conducted. The unit cost per foot is not constant, but increases with depth. The nature of the formations to be penetrated and the casing program imposed by subsurface conditions will also have an important influence on drilling costs. Wells in hard formations that must be penetrated slowly and in which the footage obtained per bit is comparatively low, will be more costly to drill than wells in soft, easily drilled formations. Heaving shales and caving formations may also cause slow progress and high cost. Necessity for cementing off top waters or imposition by state authorities of casing programs designed

*Superior figures refer to similarily numbered items in the bibliography published in the September issue of *The Petroleum Engineer*.

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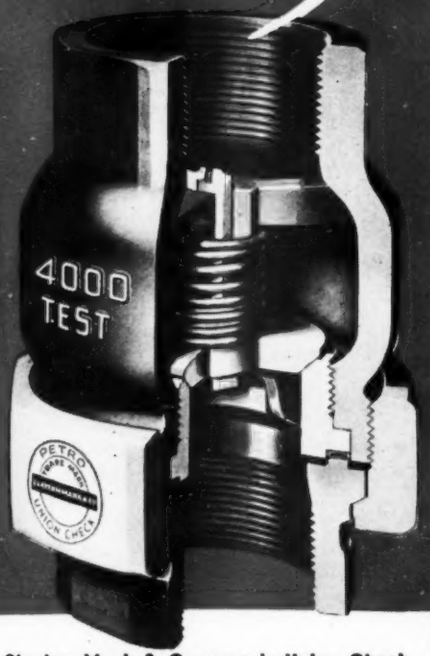

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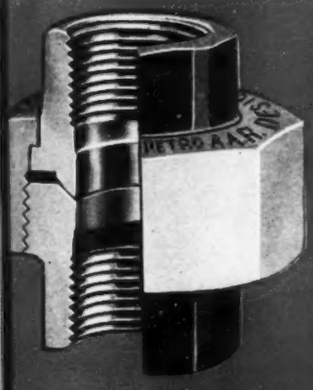

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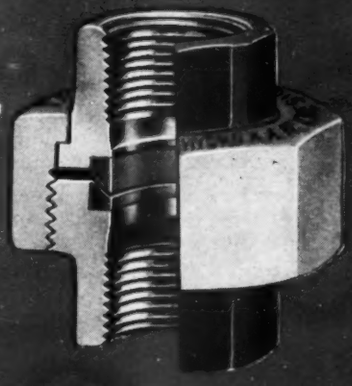

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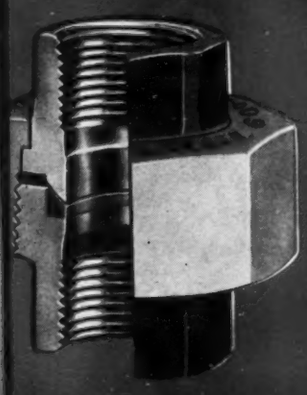

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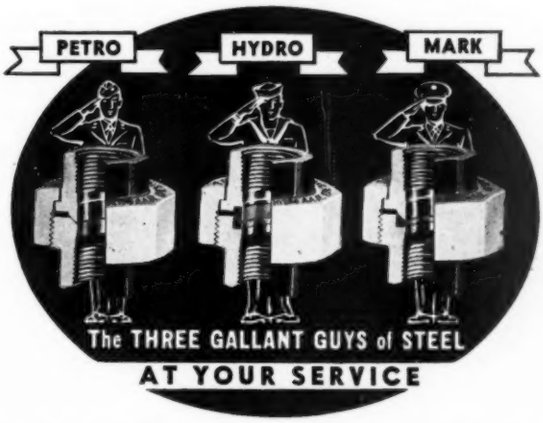

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to seal off a certain formational interval, may require an extra "string" of expensive casing that will result in material increase in the per-well cost.

The cost of operating wells after they have been completed may represent a large element of oil production cost, particularly when wells must be mechanically pumped. Lifting oil by natural flow or by gas-lift methods, is comparatively inexpensive. The rate of production per well has an important influence upon the unit production cost, and from the standpoint of cost per barrel it is advantageous to keep the rate of production per well as high as possible. High per-well yields are obtained by wide spacing. Wide spacing of wells probably results in more economical utilization of formational gas energy, which often permits procuring a greater percentage of the oil by natural flow or gas-lift than when wells are closely spaced. On the other hand, close spacing results in more rapid production of the available oil and shorter operating life for the wells. A shorter economic life means smaller overall per-well operating cost for a producing property, but this is ordinarily offset by the greater cost of operating the greater number of wells that close spacing requires.

Well operating cost increases with the depth from which production is obtained, and is governed also by conditions that influence well maintenance and equipment depreciation. Wells that require frequent cleaning and servicing and replacement of equipment are usually high-cost producers, and expense of this kind is almost directly proportional to the number of wells to be operated. Under such conditions operations are more profitable with widely spaced wells.

Influence of selling price of oil. The selling price of oil, which with production cost determines the profit to be derived from field exploitation, is widely variable and has an important influence on the spacing and pay out status of wells. The price paid to the producer for his oil depends not only upon its quality and its suitability for production of refined products, but also varies from time to time depending upon the demand for these products and the available crude oil supply. High priced oils permit of closer spacing of wells than low priced oils. Profits are larger, wells pay out in shorter time and may profitably be operated for smaller rates of production when the selling price of oil is high.

Due to over-production beyond market requirements, the selling price of crude petroleum is often lower during the early period of field development when the wells are in "flush" production, than in later life when the rate of yield has been somewhat reduced and the market has had time to become adjusted to absorb the production. Accordingly, it will sometimes be profitable to drill additional wells in the later life of a field, that would not have been economic during the earlier period of development. In time of war when demand for oil is abnormally great, or in periods in the business cycle when prices are high, it may be advantageous to space wells more closely than normally, unless the higher income resulting from such situations is offset by correspondingly high production costs.

Unfortunately, the operator cannot readily change the spacing program once development of the property is well under way. Usually, it will be necessary to determine upon a spacing interval in advance of field development, on the basis of the best information then available, and adhere to this throughout the entire period of development. If this proves to be less profitable than some other spacing interval that might have been used, little if anything can be done about it, particularly if too many wells have been drilled for best results. With this possibility in mind, the early development program may provide wide spacing with the expectation of possibly drilling intermediate locations if, in later years, market conditions should justify closer spacing. Seldom, however, will the early pattern of arrangement of widely spaced wells be adaptable to later plans involving closer spacing, unless it should so happen that the later program provides for just half as many acres per well as the original spacing. In this event, we have merely to drill "five-spot" wells midway between the earlier wells. Often, however, when the possibility of doing this becomes apparent, the field pressure will be too far reduced and rates of production of wells will be too small to make it profitable to drill the additional wells.

Selling price minus production cost equals profit. The higher the selling price, the greater the profit and the greater the margin over which costs may increase before operations become unprofitable. High-priced oil permits profitably operating wells for lower daily yields, enables a larger number of wells on a given property to pay out, and hence encourages close spacing of wells. Low-priced oil, on the other hand, may only be profitable when wells are sufficiently spaced to yield their product at substantial rates. The question of whether later intermediate wells may be drilled profitably will be largely dependent upon the price that may be realized for the product.

The individual operator has little control of the price that he receives for his oil. Usually, especially in a competitive field, he must be guided in his rate of production by the pace of his neighbors. He must take his production at a time when field pressure is high, whether or not the market for oil happens to be attractive at that time. Perhaps he is compelled to produce and market the greater part of his oil at a time when oil prices are low. If he is fortunate he may be able to produce a large part of his oil during the period of flush production, at a time when oil prices are high, thus achieving the triple advantage of high price, low cost, and short period of realization.

In a unitized field or where operations are controlled cooperatively, the production may be curtailed or even withheld entirely in times of price depression and forced to the maximum when prices are high. Thus a higher average price is received for the product of the field, though profits will be tempered somewhat by deferred realization. In a cooperatively controlled field scientific well spacing is possible. Operators may drill just the correct number of wells to achieve the most profitable rate of recovery with due regard to prospective market demand, price, and production cost.

Influence of discounted value of deferred income. A dollar due at some future time is not worth its face value today. Present-day values of future income are discounted values resulting from application of an interest charge reflecting the earning capacity of capital over the period of deferment. Money in the bank or invested in industrial enterprise earns interest. Oil in the ground earns none. Furthermore, oil in the ground is subject to heavy taxation and earnings paid out in dividends or invested in securities or held in bank balances is usually less heavily taxed.

Ralph Zook Heads I. P. A. A.

Ralph Zook, Sloan and Zook, Bradford, Pennsylvania, was elected president of the Independent Petroleum Association of America at the annual meeting in Fort Worth, Texas. He succeeds Frank Buttram, Oklahoma City, Oklahoma, who retires after four terms.

Nine new members were elected to the executive committee, as follows: O. L. Sturbois, Vincennes, Indiana; W. A. Moncrief, Fort Worth; R. J. St. Germain, Houston, Texas; J. A. McCarty, Wichita Falls, Texas; J. D. Sandefer, Jr., Breckenridge, Texas; L. L. Aubert, Los Angeles, California; Emery Carper, Artesia, New Mexico; C. H. Lyons, Shreveport, Louisiana, and H. M. McClure, Alma, Michigan.

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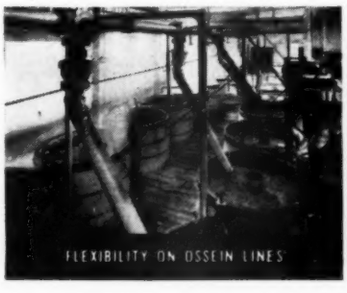
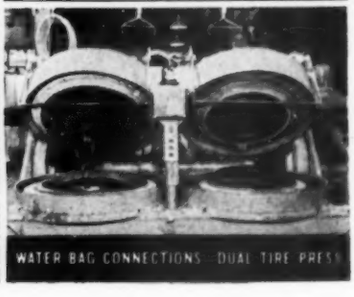

FLEXIBILITY ON OSSEIN LINES

ALTERNATING STEAM AND WATER CONNECTIONS

FLEXIBILITY IN MUD PUMP LINES


WATER BAG CONNECTIONS—DUAL TIRE PRESS

Hence, there is financial advantage in early recovery and sale of oil and gas reserves. The shorter the period of realization, the greater will be the present worth of the property, and rapid recovery is achieved by close spacing of wells.

The loss due to deferred realization on oil and gas values may be substantial when a high rate of interest is involved. Opinions differ on what constitutes a proper interest rate to employ in calculations of this character. Some authorities reason that the appropriate interest rate to use should be that properly earned by capital invested in the industry itself. The oil producing industry is somewhat speculative in character, and capital invested in it should be expected to earn an interest rate that will include an increment reflecting the degree of risk involved. According to some authorities, 10 percent is not too high a rate for the average oil producing enterprise with proved reserves. Certainly it should not be less than 6 percent. Discounted at the rate of 10 percent, a dollar due 5 years hence is today worth only 62.1 cents; and 10 years hence, only 38.6 cents. Even at 6 percent, future income due 5 years hence suffers a loss of more than 25 percent of its face value and with 10 years deferment, loses nearly 45 percent of its value. The penalty for delay in production is heavy and will sometimes more than offset the cost of drilling and operating a number of additional wells that will materially reduce it. It would appear that there is a certain optimum acreage per well, beyond which the interest cost of deferred production exceeds the cost of drilling.

Interest cost of deferred "pay out" of wells. A large part of the working capital of an oil-producing company is invested in the drilling of wells. This capital must be amortized out of profits and a reasonable rate of interest earned on the outstanding or unredeemed principal before operations may be said to be profitable. Although, for accounting purposes the cost of drilling the well should be spread over its entire life-time production so that each barrel of oil ultimately produced is made to bear its share of the development expense, many operators prefer, for their own purposes, to allocate the early revenue in excess of operating expense exclusively to the amortization of invested capital, reserving all thought of profit until the capital invested in development is fully redeemed. Thus, a well is said to pay out when it has returned its original cost with a proper rate of interest on unredeemed capital, plus cost of operating the well during the pay-out period.

As explained, the interest rate appropriate for an oil-producing enterprise is properly of the order of 8 to 10 percent, and the interest cost of capital invested in the industry is therefore a factor of considerable importance. For example, a well costing $125,000 to drill and 40 cents per bbl. of production to operate, and restricted by proration requirements to, say, 35,000 bbl. per year will, if oil sells for $1 per bbl., pay out in its ninth year if the interest cost of capital is 8 percent. During this time, use of the capital expended in drilling the well will cost approximately $51,600.

Close spacing of wells, though recovering the producible oil in shorter time, will increase the length of time necessary for wells to pay out, because of the smaller per-well rate of production and the greater amount paid in interest on invested capital. Widely spaced wells with larger individual and better sustained productions pay out in shorter time and with a smaller interest charge for use of capital.

It will be noted that the interest cost of capital and the interest cost of deferred production are opposing factors. Interest cost of capital is reduced by wide spacing of wells, whereas the interest cost of deferred production is reduced by close spacing of wells. A balance must be sought between these opposing factors that will depend upon the interest rate charged, the capital cost of wells, the rate of production, and the selling price of the oil.

Influence of proration. During the last decade or more, there has existed in the United States an oil-producing capacity in excess of market needs. In order to prevent serious over-production, drastic price reduction and wasteful use, the practice of proration has come into vogue as a means of production control. Under state regulation fostered by agencies of the federal government—or in some jurisdictions where state conservation laws do not exist, by cooperative agreement among producers—the right of each operator to produce is restricted to what is considered to be his fair share of the market outlet. In some fields curtailment is drastic and operators are permitted to produce but a small percentage of their potential production. Gradually this method of production control has taken hold of the petroleum industry until today it dominates the entire outlook of the industry, even to the point of determining the spacing of wells.

Confronted with this system of regulation that restricts the outlet for the production of his property to a certain rate of production, the control of his property and the opportunity for economic planning of his field exploitation program is largely taken out of the hands of the oil producer. He is compelled to pattern his field development program to accord with the dictates of an agency beyond his individual control. His freedom of action and decision is greatly curtailed. This agency may be paternalistic in the sense that it insists on what is considered best for the industry as a whole, but its dictates may at times be directly at variance with the financial interests of the individual producer. The informed operator does not object to this system of production control, for it is a necessary institution, designed to procure the economic balance of a great industry. Without it chaotic conditions would exist, conditions that would preclude profits for all but a few of the more fortunate operators. The producer must strive, rather, to adapt his program to meet the requirements of the proration authorities, yet procure for himself such advantages as may be possible within the framework of the governing rules.

The basis for computing proration allowances varies in different jurisdictions. The most common method has been to allow each well to produce a certain percentage of its estimated potential production. Other methods have been based in whole or in part on productive acreage owned, or formation pressure. Depth of wells and specified minimum and maximum rates of production have been factors in some proration formulae. No one basis is productive of fair results under all circumstances, and thus administrative agencies have often been tolerant in seeking the most acceptable method of computing the allowable rates of production, permitting one basis in some fields and another in others.

When potential production of the individual well is the basis for computing the proration allotment, an operator seeking to increase the market outlet for his property is encouraged to drill additional wells. If the system of proration provides that each well may produce the same percentage of its potential, irrespective of the number of

Bottom-Hole Test Almost Too Late

Two pressure-test bombs were recovered after what is thought to be the longest bottom-hole pressure test ever made. The bombs were lost in the Shell Oil Company's well No. 10 Watson, near Kilgore, Texas, when a bottom-hole test was run in March, 1933. During the 10 years since efforts made to recover them were unsuccessful. When workmen brought them to the surface, one was in good condition and the other needed repairs.

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wells or their spacing, the operator with closely spaced wells gains an unfair advantage over his neighbors who, perhaps, have been more conservative in planning their spacing program. Overdrilling, encouraged by this system of proration, has resulted in excessive development costs in some fields. In many instances the assigned quotas can be produced with but a small percentage of the wells actually drilled. Thus, economic waste has resulted.

As additional wells are drilled, beyond what are needed to produce the field quota, the allowable production for the individual well must necessarily be reduced. Gradually, the per-well "allowable" is diminished until the individual well may not produce enough to pay out in a reasonable time.[9] The entire enterprise may become uneconomic; yet with fewer wells, a very profitable result might be attained.

Some years ago, the Well Spacing Committee of the American Petroleum Institute collected data indicating the number of unnecessary wells that had been drilled in various fields, and a very substantial economic loss in excessive drilling was disclosed. Unnecessary wells are so characterized if they do not increase the ultimate recovery by an amount sufficient to return the additional cost, and if it is possible to produce the field quota of allowable prorated production without them. In the East Texas field,[9] for example, several authorities agree that as many as 12,500 unnecessary wells have been drilled at a total cost of $162,000,000. In the Oklahoma City field, it is asserted that approximately 400 unnecessary wells were drilled at a cost of $46,600,000. In the single year 1937, D. R. Knowlton [20] estimates that wells unnecessarily drilled in United States fields cost the industry as much as $100,000,000.

Within recent years, the courts and state conservation enforcement agencies have recognized, and those engaged in the industry have come to accept, the principle that an operator is entitled to produce ultimately no more than the recoverable gas and oil originally present in the reservoir rocks included within his property boundaries. Recognition of this principle justifies regulatory control of each producer's operations to see that he takes no more oil than that to which he is entitled, and that he consumes no more than his fair share of the available reservoir energy in its production. In practical application of this principle, some state proration authorities have claimed the right to regulate the spacing of wells. Thus, 10-acre spacing is imposed by state enforcement agencies in some jurisdictions.

Summarizing the results of its studies, the Well Spacing Committee of the American Petroleum Institute in May, 1938, issued a report in which it was asserted that the rate of withdrawal of oil from a well materially influences its drainage area; that "the same or greater efficiency of recovery can be obtained by wider spacing of wells at lower rates of flow per acre than by close spacing at excessive rates per acre." It is further stated that under restricted production, such as has been imposed during recent years by proration, the drainage area becomes so great as to become indeterminate, and for all practical purposes is fixed by whatever geometrical pattern may be prescribed by other considerations, particularly by the most advantageous rate of withdrawal. The committee stressed the view that for greatest ultimate recovery, ratable withdrawals from the reservoir must be maintained and proportioned to the quantity of recoverable oil originally existing in the reservoir under each tract.

A Sub-Committee of the Institute's Well Spacing Committee, in a report discussing the "Legal Phases of Well Spacing," also dated May, 1938, recommends that state laws should recognize the necessity for, and regulatory agencies should prescribe a uniform drilling pattern for each field and adopt a system of allocating production that will place emphasis upon drainage or proration "units" in which acreage rather than well potentials will be the controlling factor in assuring ratable production. It is further urged that owners of small or irregularly shaped tracts be required to pool their properties when necessary to preserve a uniform spacing pattern.

In December, 1936, the "Committee of Nine" of the Mid-Continent Oil and Gas Association, issued a report emphasizing the evils attending unnecessary drilling in proved fields.[24] This committee recommended that proration allowances be based upon a "proration unit" equivalent to the area that is drained efficiently by one well, and that the well spacing pattern should contemplate the provision of one well for each proration unit. It is further suggested that the acreage assigned to a proration unit might vary depending upon estimates of the amount of recoverable oil in different parts of the field. The view is emphasized that proration authorities, by basing their proration allotments upon well potentials rather than acreage, in effect compel the more conservative operators to drill more wells than economic considerations would indicate to be advisable.

Although there have thus been powerful influences at work tending to force development in the newer fields to follow a pattern providing for wide spacing of wells, it must be recognized that this policy has been dictated by a situation wherein a potential capacity to produce greatly in excess of market needs had developed. This surplus productive capacity need not necessarily persist. Indeed, as a result of the accelerated demands of our wartime economy, and failure to find new reserves to compensate for current withdrawals, the proration situation today is much less acute than during the pre-war decade. Should the war continue for several years, increased demand for oil products, diminished reserves, and higher prices may shortly compel closer spacing than competent authorities have recently considered advisable. Nature's forces influencing the spacing of wells may be difficult to appraise but they are unchanging; they will be the same next year as they are today. Economic forces are influenced by unpredictable events and no man can chart their future course with certainty. The oil producer who must appraise both in planning his well spacing program is indeed confronted with a most complex problem.

☆ ☆ ☆

Army Revises Motor Fuel Specifications

All types of motor fuel sold for military use must now pass a modified oxidation stability test, it has been announced by the War Department.

The amended specifications establish a maximum pressure drop of 2 lb. per sq. in. in 7½ hours. Otherwise, the procedure remains the same as under the original Specification No. 2-103A dated March 2, 1942.

The new requirement affects all three types of 80-octane gasoline. The revision of standards was made by the Fuel and Lubricants Division, Office of The Quartermaster General, after a meeting of representatives of the petroleum industry, the British, and the United States Army and Navy.

Subsequent to the meeting, a survey conducted by the Petroleum Administration for War indicated that inhibitor supplies would be ample to permit inclusion of such a requirement in the specifications for military fuel.

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Interference on Telephone Lines Caused by Cathodic Units

☆ Steps involved in solving problem to satisfaction of telephone and pipe line officials

PART 1

by Paul F. Marx

Technical Engineer, U. S. Maritime Commission

IN THE field of cathodic protection, many difficult problems arise. One problem that has presented more difficulty than others in the same category is discussed in this article.

Rural telephone circuits, as well as some toll lines, are often affected by noise interference if in the vicinity of pipe lines that are protected by cathodic units. This condition is predominant in rural districts because their telephone lines use a grounded circuit, or the particular companies do not have the means to keep their lines in proper repair.

This noise, if created by a 5 kw., d-c., shunt-wound generator, connected to a 4-cylinder, natural gas engine, when interposed on the telephone circuits is often so severe that conversations become impossible.

Trouble on the telephone lines was first experienced by the operator on a toll line about 18 miles from a cathodic unit and approximately 8 miles from a pipe line. Complaint was made to the lineman that usually when that circiut was in use, "It sounded like an engine running." It was thought that the cause was from the local power plant, but it could not be traced. At a later date, the operator in a second town about 10 miles from any unit complained to a lineman of a similar condition of engine noise. This condition was most noticeable, she said, when she plugged in a rural customer at the end of the line about 12 miles south of town.

The linemen and operators got together and also contacted a third town. They found that certain circuits and combinations of circuits were very distressing so far as noise and telephone interference was concerned. At times normal conversations were impossible and the constant noise brought many complaints from the subscribers.

Up to this time, not once was the cause thought to be from the remotely located units of the pipe line. Then, one day a lineman was doing some repair work and testing on a pole in the vicinity of three cathodic units. These units were situated within a radius of one and one-half miles. They happened to be shut down on account of tests and were put into operation at the particular time that he was there. He noticed that the lines had been quiet and when the units were started the noise returned to the lines. The pipe line company was contacted and the search for the trouble began.

The first thought was that the engine ignition was causing the trouble. Suppressors were put on the spark plugs but these had no effect and the trouble remained. With the use of a telephone test set attached to the telephone wire directly over the unit, tests were made. The noise varied in proportion to the d-c. output of the generator. As the speed of the engine was increased, the noise level remained constant but the tone cycles on the telephone circuit in-

(Continued on Page 128)

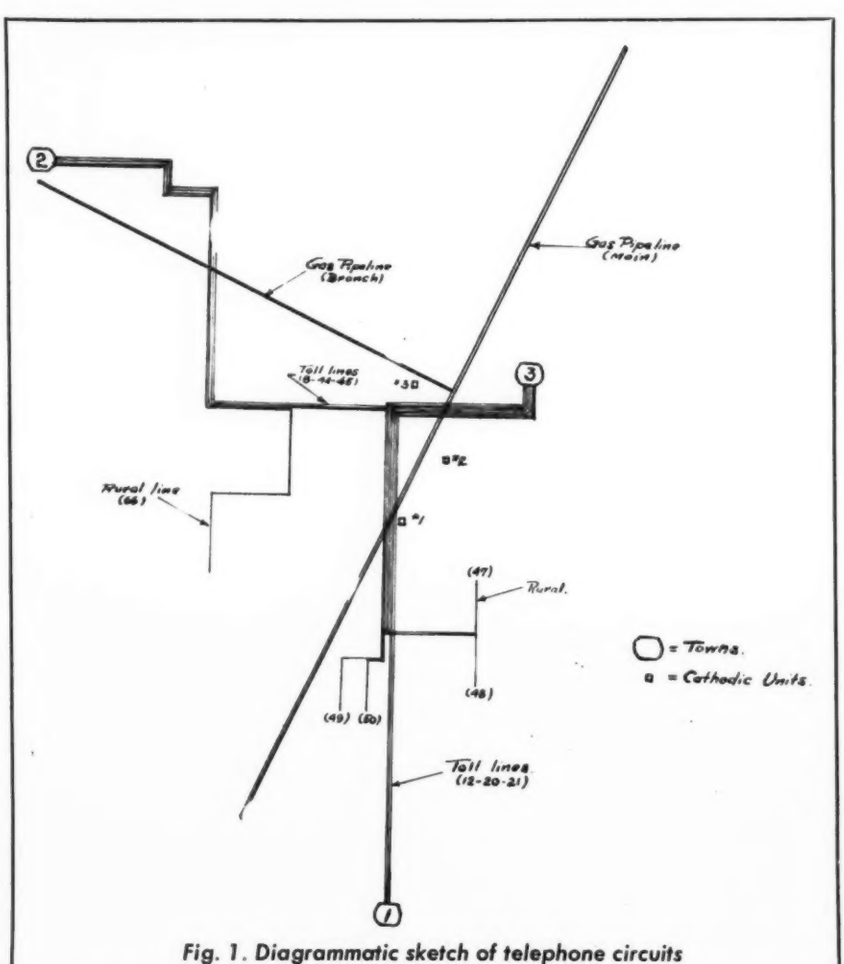

Fig. 1. Diagrammatic sketch of telephone circuits

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order that the general understanding we reached, during early days of our engagement ther in this war, may be perfectly carried out, and der as a practical matter to d the prodigal use of man- er and shipping that would ult from pursuing any other rse, I am directing the War ipping Administration, under propriate bareboat arrange- ents, to number to your flag r temporary wartime duty dur- g each of the suggested next en months a minimum of fifteen ships.

I have furthermore suggested to them that this be increased to twenty.

We have been allocating to British services on a voyage-to-voyage basis large numbers of American-controlled ships. What I am now suggesting to you, and what I am directing the War Shipping Administration to carry out, will be in the nature of a substitution to the extent of tonnage transferred for the American tonnage that has usually been employed in your war program.

Details of the arrangements we can properly leave to national shipping authorities for settlement through the Combined Shipping Adjustment Board, whose function it is to concert employment of all merchant vessels, and will in accordance with its usual practice do so in connection with these particular ships.

Always sincerely,

FRANKLIN D. ROOSEVELT.

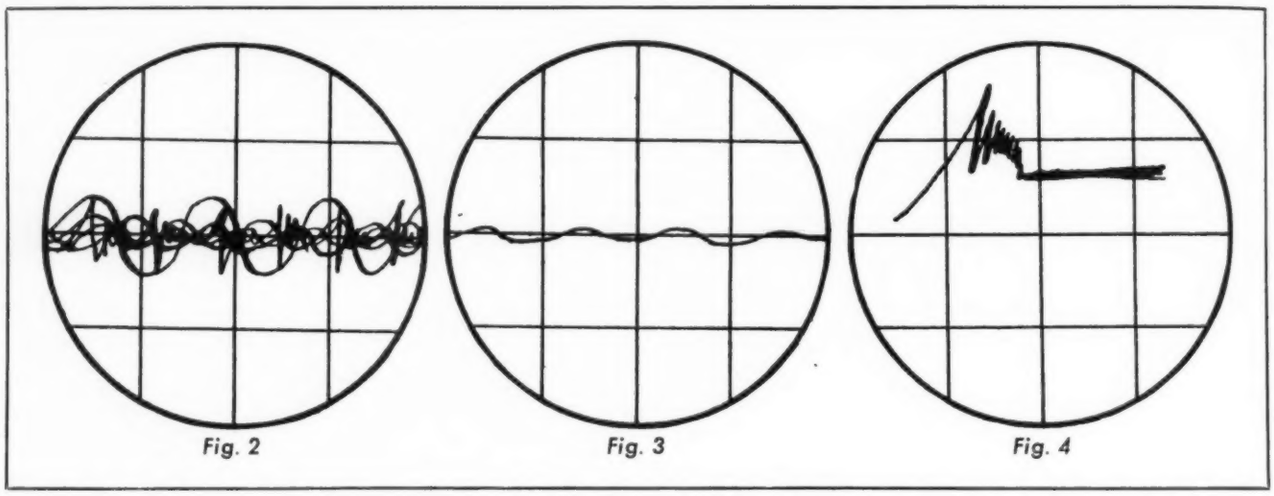


Fig. 2 Fig. 3 Fig. 4

(Continued from Page 124)

creased. When the speed was reduced the tone cycles became fewer.

Further checks indicated that the source of the trouble did originate in the motor-generator set. So the brushes were lifted individually, and the noise level increased each time a brush was removed. This led to the wrong conclusion that the arcing brushes were the cause of the trouble. The brushes were sanded to no avail. Various types of brushes were used: High copper content brushes, graphite brushes, and a combination of these. The armature was then removed and taken to an electric shop where the commutator was turned, undercut, and polished. Upon reinstallation the troublesome noise remained on the telephone circuit.

The next consideration was the negative cable. The negative cable at this particular unit, which joined the pipe line to the unit, was an underground cable. It ran at right angles to the unit and passed directly underneath the telephone wires. This was dug up and a shielding put over it, thinking that induced frequencies might be causing the trouble. This was not the case, however.

It was found that when the unit was running idle, that is, the generator was not loaded because the ground bed was disconnected, the noise was negligible. This led to other trends of thought.

All telephone circuits in this vicinity were single wire and grounded. It was impossible to metallize these circuits because of the expense. Therefore, other steps had to be taken.

Seven circuits passed this location on the same pole line, and these were transposed after a fashion but this operation failed to help.

Two thousand feet of wire, a thousand feet on either side of the unit, was cut into the circuit and parallel to it. At each end it was cross-connected into the circuit and grounded. This had no effect.

Resistance was cut into the telephone circuit. This decreased the noise, but also lowered the efficiency of the circuit to an impracticable degree. It was noted that each time a rural subscriber lifted his telephone receiver from the hook the noise level would increase. Resistances were cut into some of these circuits between "grounds," but had to be removed, because they were of no consequence.

On one occasion an insulator broke on the telephone pole and the wire swung over and touched the branches of a tree causing the noise level to rise sharply. This was due to the wire making an additional ground.

At one point along the pipe line where a vent projected into the air and was very close to a telephone wire, the noise level increased and it was thought the trouble might be from induced currents.

As units No. 2 and No. 3 were more than half a mile from the closest telephone line, they were not considered as contributing factors involved in the investigation.

These trends of thought resulted in no conclusion, so it was decided to study the varying conditions with the aid of an oscillograph. This was set up in the telephone office of the third city mentioned, which had the largest office of the towns involved. The operators of all towns involved were contacted and various combinations of circuits were made, as previously mentioned.

It was possible to see variations in disturbances only by observing the

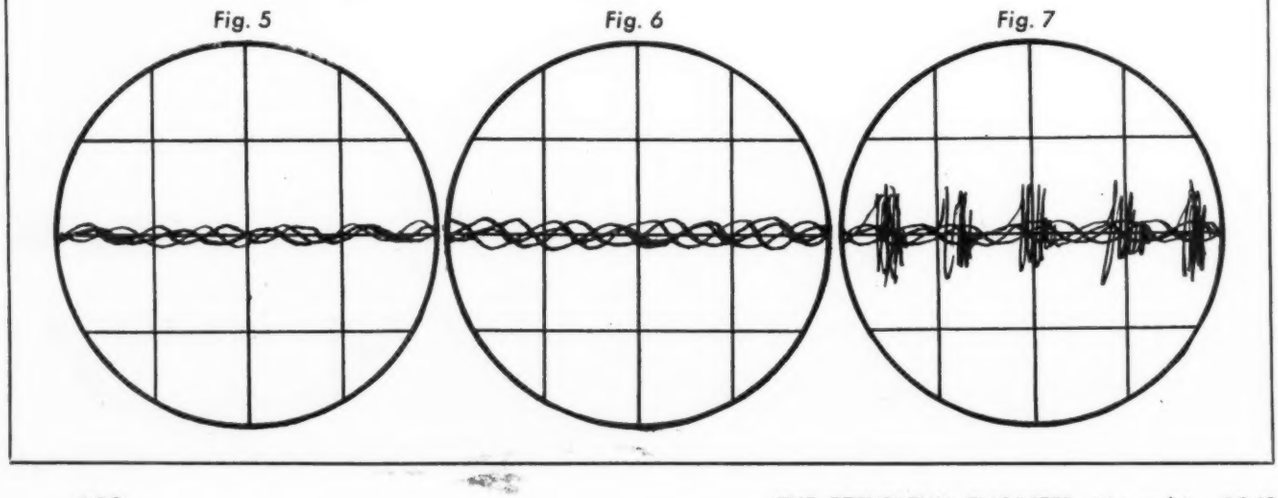
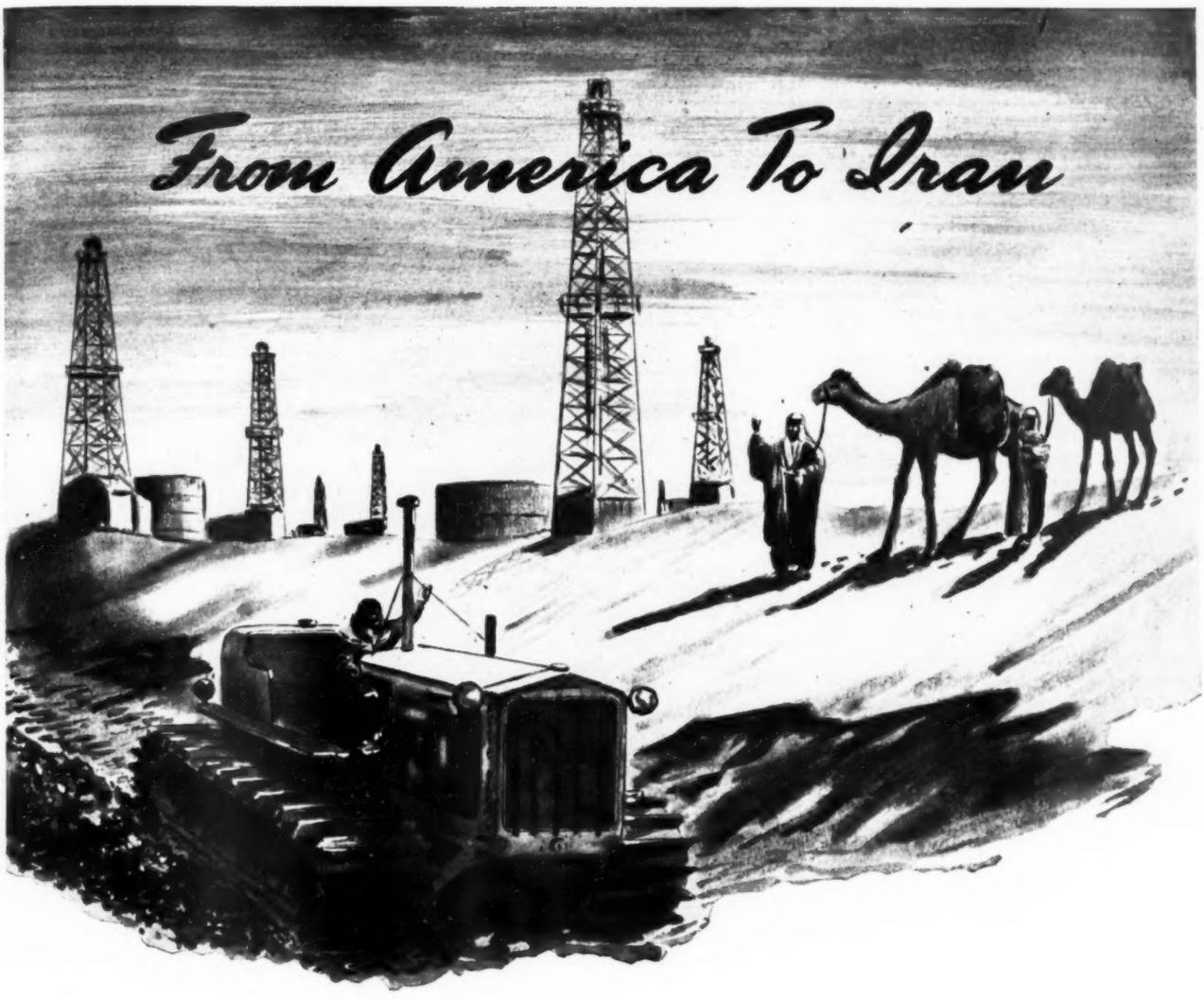


Fig. 5 Fig. 6 Fig. 7



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scanning disk of the oscillograph. They could not be determined audibly.

When all three units were operating, and telephone toll circuits 18, 44, 45, 12, 20, and 21 were plugged in, a conglomeration of interposed curves resulted. (Fig. 2.)

When the three units were shut down the interference consequently ceased and the conglomeration of curves settled down to a smooth curve. (Fig. 3.)

As a matter of interest, when an operator would "ring" the curve took a peculiar shape. The base line rose rapidly and then settled back gradually. (Fig. 4.)

When only the No. 1 cathodic unit was running, the interference could be seen when toll lines 12, 20, and 21 were in operation. (Fig. 5.)

When receivers were lifted on local lines 47, 48, 49, and 50, and these circuits plugged in at the main switchboard, the interference was magnified. (Fig. 6.)

The interesting condition referred to earlier in this article, which seemed as perplexing, was solved with the aid of the oscillograph which was still at town No. 3. The condition referred to was the one when the customer at the end of rural line, 66, was talking to the operator at town No. 2. Then the noise level was extremely high and tone cycles could be heard plainly. They sounded like engine revolutions intermingled with a heavy hum. Although this rural line 66 was far removed from any cathodic unit, the cause of the interference was directly from unit No. 3.

The final conclusion reached was that the a-c. ripple from the d-c. generator was the cause of all the interference. The troublesome frequencies in this particular instance filtered through the ground and were carried along the branch gas pipe line until it crossed telephone line 66. This telephone circuit 66 paralleled toll lines 18, 44, and 45 for a number of miles. The induced currents on toll lines 18, 44, and 45 were transmitted to the toll lines 12, 20, and 21 and could be seen on the oscillograph as well as heard on the telephone receiver. This noise was also induced on rural lines 47, 48, 49, and 50, which paralleled toll lines 18, 44, and 45 into town No. 3.

The oscillograph showed that arcing brushes will cause considerable noise. When one brush was lifted off the commutator, and the remaining brushes carried the excessive load, causing considerable arcing, the vertical sweep on the oscillograph scanning disk was high. (Fig. 7.)

Other conditions effecting noise are: (1) Non-uniform air gaps in generator field coils, due to the variation in magnetic flux densities around the poles, and (2) heterogeneous iron cores containing soft spots.

The location of the cathodic unit bed is not a factor leading to the telephone interference.

After definitely determining the cause to be an a-c. commutator ripple, calculations were made to find some type of a filter that could be used to absorb the ripple.

The oscillograph was employed to find the frequency of the a-c. ripple. The horizontal sweep of the oscillograph was synchronized and locked and a comparison made to a 60-cycle a-c. wave.

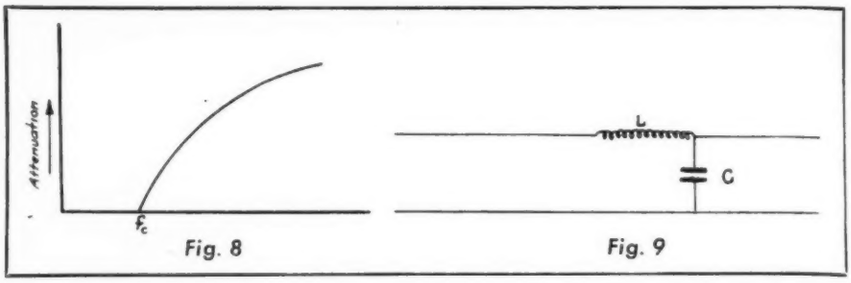


Fig. 8 Fig. 9

Innumerable frequencies were encountered ranging from approximately 200 cycles to 2000 cycles. The most troublesome frequency, however, seemed to be about 1000 cycles.

After finding the number of cycles involved, it was not possible to use the formula for a "constant K low pass filter" dealing with one definite frequency, as shown below.

The type curve is shown in Fig. 8 and the wiring diagram in Fig. 9 for constant K low pass filter. The formula is as follows:

$$L = \frac{R}{\pi f_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C = \frac{10^6}{\pi f_c R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where:

L = the inductance in henrys,

R = load impedance in ohms,

f_c = cut off frequency in cycles per sec., and

C = capacitance in microfarads.

Assuming the fundamental frequency to be based on slot harmonics, then:

$$F = SN \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Where:

F = frequency,

S = total number of slots, and

N = r.p.m./60 = armature speed per sec.

If: S = 94 slots

R.p.m. = 700

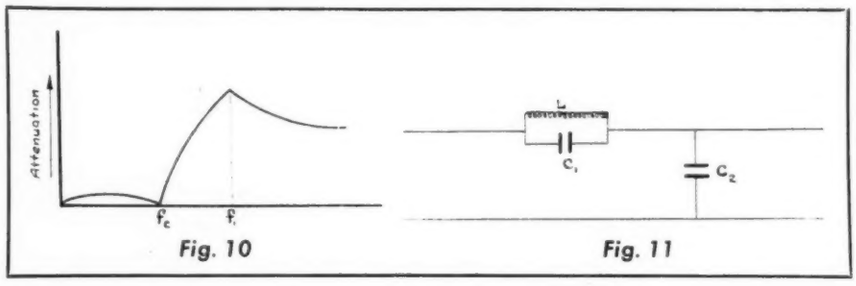


Fig. 10 Fig. 11

Then: $F = \frac{94 \times 700}{60} = 1097$

When the cathodic unit is running at 700 r.p.m. this particular generator, especially wound for high resistance, developed 75 volts and 52 amp., and

R = 1.4 ohms

Then from equations (1) and (2)

$$F = \frac{1.4}{\pi 1097} = 0.0004 \text{ henrys}$$

$$C = \frac{10^6}{\pi 1097 \times 1.4} = 207 \text{ microfarads}$$

The choke coil then requires 0.4 millihenrys inductance and the capacitor 207 mfd. capacitance.

As this filter only eliminates the noise

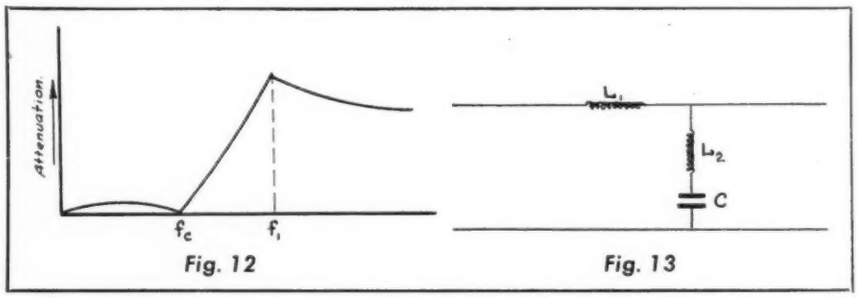
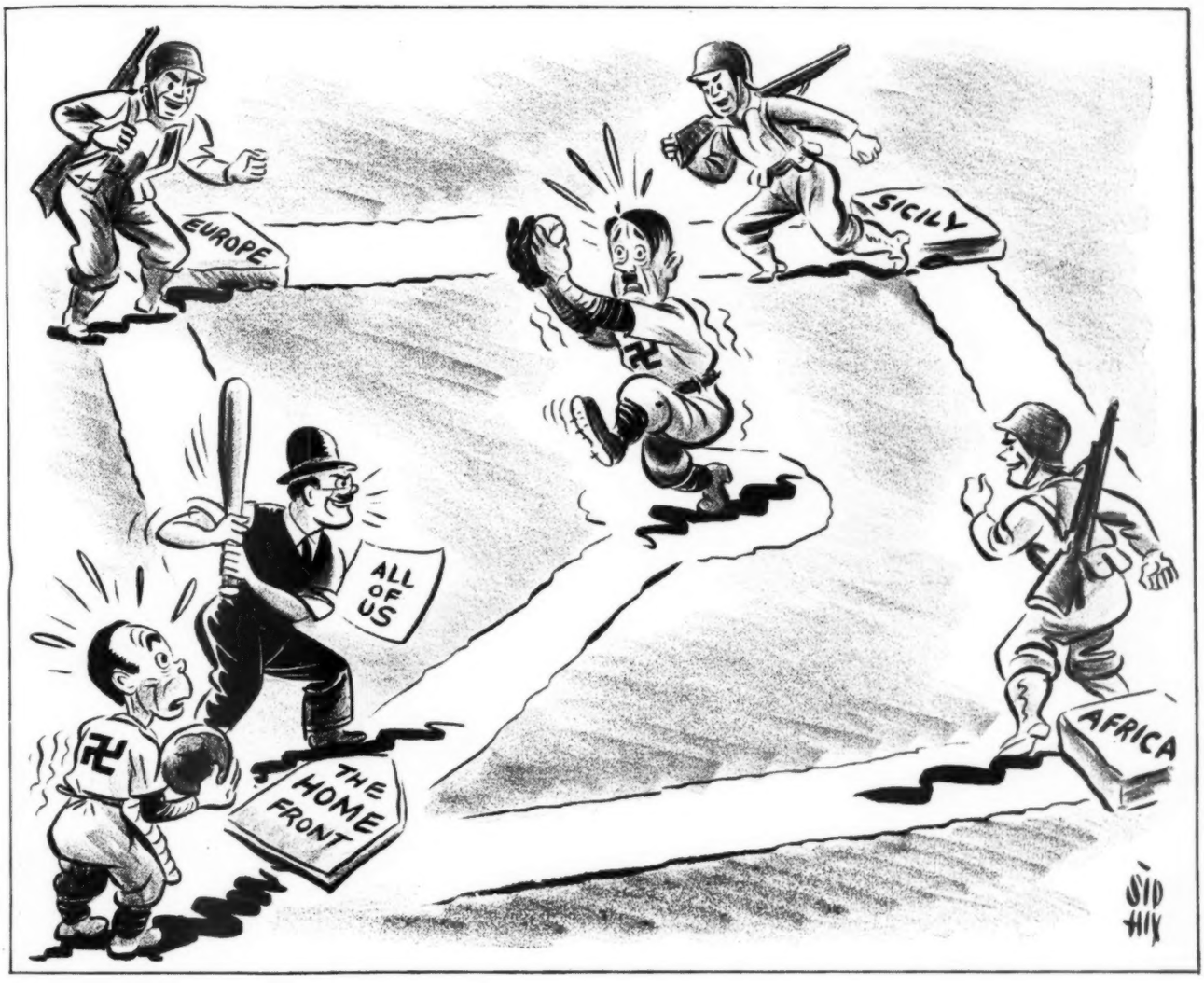


Fig. 12 Fig. 13



MEN ON BASES CALL FOR *SPECIAL* EFFORT!

Yes, we have men on bases—in Africa, in Sicily, in Europe and in many Pacific islands. But men on bases don't win ball games. To score a victory, we've got to drive them home, and that calls not for a slowing down of effort but for the full use of all of the energy, all of the strength and all of the skill we possess . . . Gaso Pump & Burner Mfg. Co., 902 East First Street, Tulsa, Oklahoma. Export Office: 149 Broadway, New York. Shreveport: W. L. Somner Co., 419 Lake Street. Los Angeles: Service Oil Field Supply Co., 5333 S. Riverside Drive.

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from this one frequency, it did not suffice.

The following formulae have the advantage over the foregoing as the greatest attenuation is at the troublesome frequency "f_1" with attenuation for all frequencies above the cut-off frequency "f_c".

For shunt M derived low pass filter, the type of curve is shown in Fig. 10 and the wiring diagram in Fig. 11. The formula is as follows:

$$L = \frac{mR}{\pi f_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$C_1 = \frac{(1 - m^2)\,10^6}{4m\pi f_c R} \quad . \quad . \quad . \quad . \quad (5)$$

$$C_2 = \frac{m\,10^6}{\pi f_c R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$m = \sqrt{1 - f_c^2/f_1^2} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For series M derived low pass filter, the type of curve is shown in Fig. 12 and the wiring diagram in Fig. 13. The formula is as follows:

$$L = \frac{mR}{\pi f_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$L_2 = \frac{(1 - m^2)R}{4m\pi f_c} \quad . \quad . \quad . \quad . \quad (9)$$

$$C = \frac{m \times 10^6}{\pi f_c R} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

$$m = \sqrt{1 - f_c^2/f_1^2} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Where:

L, L_1, L_2 = inductance, henrys,
R = load impedance, ohms,
f_c = cut-off frequency, cycles per sec.,
f_1 = troublesome frequency, cycles per sec., and
C, C_1, C_2 = capacitances, mfd.

In the given problem the following conditions are known:

R.p.m. = 700
S = 94
R = 1.4
f_1 = 1097 (from equation 3)
f_c = 400 (from oscillograph)

Solving the "shunt M derived low pass filter":

$$m = \sqrt{1 - f_c^2/f_1^2} \quad . \quad . \quad . \quad . \quad (7)$$

$$m = \sqrt{1 - 400^2/1097^2}$$

$$m = 0.931$$

$$L = \frac{mR}{\pi f_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$L = \frac{0.931 \times 1.4}{\pi 400}$$

$L = 0.0010$ henrys or 1.0 mh.

$$C_1 = \frac{(1 - m^2)\,10^6}{4m\pi f_c R} \quad . \quad . \quad . \quad . \quad (5)$$

$$C_1 = \frac{(1 - 0.931^2)\,10^6}{4 \times 0.931\pi 400 \times 1.4}$$

$C_1 = 20$ mfd.

$$C_2 = \frac{m10^6}{\pi f_c R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$C_2 = \frac{0.931 \times 10^6}{\pi 400 \times 1.4}$$

$C_2 = 529$ mfd.

Solving the "series M derived low pass filter":

$$m = \sqrt{1 - f_c^2/f_1^2} \quad . \quad . \quad . \quad . \quad (7)$$

$$m = \sqrt{1 - 400^2/1097^2}$$

$$m = 0.931$$

$$L_1 = \frac{mR}{\pi f_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$L_1 = \frac{0.931 \times 1.4}{\pi 400}$$

$L_1 = 0.0010$ henrys

$$L_2 = \frac{(1 - m^2)R}{4m\pi f_c} \quad . \quad . \quad . \quad . \quad (9)$$

$$L_2 = \frac{(1 - 0.931^2)\,1.4}{4 \times 0.931\pi 400}$$

$L_2 = 0.000039$ henrys

$$C = \frac{m \times 10^6}{\pi f_c R} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

$$C = \frac{0.931 \times 10^6}{\pi 400 \times 1.4}$$

$C = 529$ mfd.

Although magnetic calculations follow electrical calculations, it is impossible to obtain the same precision with magnetic calculations.

The irregularity of magnetic paths, as well as their indeterminate geometrical shapes, make direct relationships of permeability, flux densities, etc., difficult.

Various handbooks show formulae for calculating the number of turns required for a coil by the cut and try method, or graphically.

For the problem at hand, however, approximation may be obtained by a revision of a formula of Armagnet, translation from the French by Kenyon, as follows:

$$N = \sqrt{\frac{L \times 10^9}{203.2\,d}} \quad . \quad . \quad . \quad . \quad (11)$$

Where:

L = inductance in henrys,
d = diameter of coil, in., and
N = number of turns.

Calculating the turns required from the inductance obtained in the two foregoing problems we have:

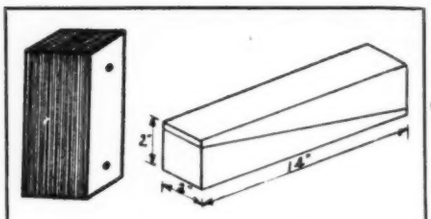


Fig. 16

Fig. 17

From equation (4) : $L = 0.001$ henrys
Assuming $d = 2.25$ in.
Then:

$$N = \sqrt{\frac{0.001 \times 10^9}{203.2 \times 2.25}}$$

$N = 47$ turns

and from equation (8), and equation (9):

$L = 0.001$ henrys
$L_2 = 0.000039$ henrys
If d remains 2.25 in.
$N_1 = 47$ turns
$N_2 = 9$ turns

The wiring diagrams for the two types of filters are shown, Fig. 14 for shunt M derived from low pass, and Fig. 15 for series M derived from low pass.

A filter was made with a combination of the above size choke coils and capacitors. The core of the coil was made of sheet transformer steel, the sheets being 2 in. wide and 9 in. high. These were laid together until the laminations were 2 in. thick, then riveted and taped. (Fig. 16.)

A wooden oak block 2 in. square and 14 in. long was made in two pieces so it could be removed from the coil after winding. (Fig. 17.)

This block or false core was chucked in a lathe and 50 turns of D.C.C. magnet wire 0.130 in. × 0.560 in. wound on it. The core was then removed, wrapped with tape, and painted. It was then possible to slip the laminated core within the coiled wire to make a laminated coil, or it could be lifted out to make an air core coil.

The capacitors used in making the filter to obtain the 529 mfd. required were 110 volt a-c. motor starting capacitors, 120-150 mfd. Four of these were used in parallel and fused for protection.

Editor's Note: This article will be concluded in an early issue.

☆ ☆ ☆

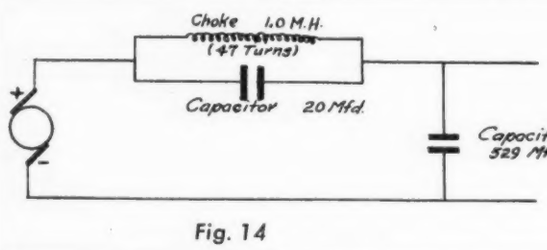


Fig. 14

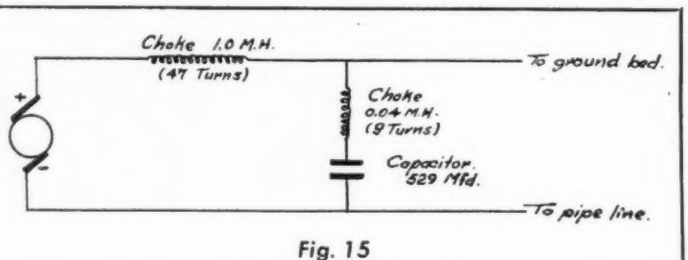


Fig. 15

P 624.
P 772.3

Calculating Pipe Sizes For Compressor Cylinders

☆ **A new method of determining diameter of suction and discharge lines**

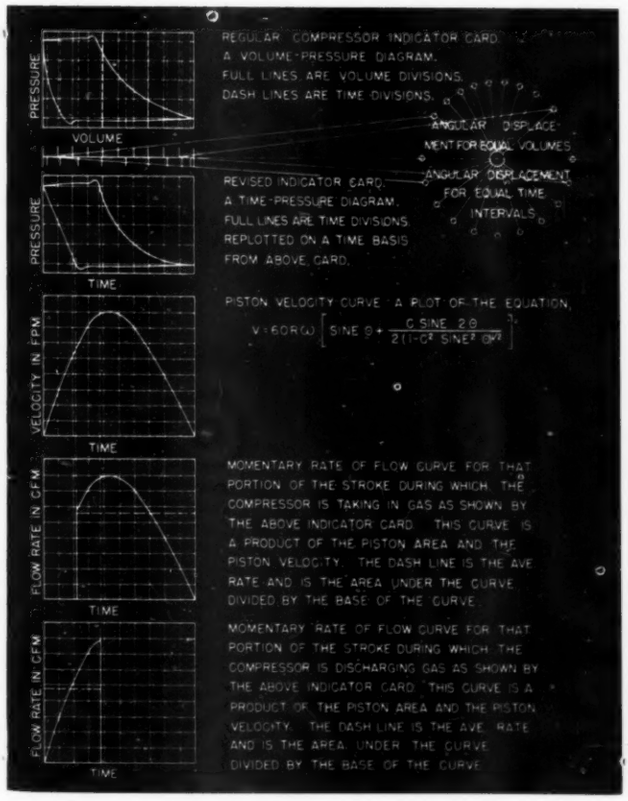
by B. C. Thiel

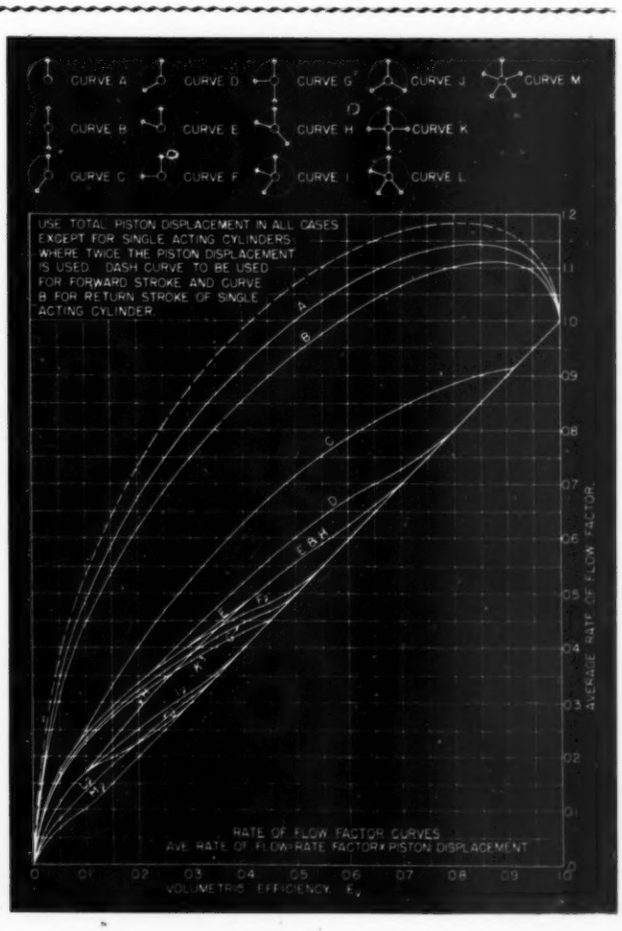
Consulting Engineer, The Cooper-Bessemer Corporation

NUMEROUS methods are used in calculating the diameter of pipe to be used for the suction and discharge lines of a reciprocating compressor cylinder. The most common method, however, is to divide the capacity of the compressor in cubic feet per minute, measured at the pressure and temperature obtainable at the inlet or outlet connection of the compressor cylinder, by the permissible gas velocities in feet per minute through these pipes and thus arrive at the internal area of these pipes in square feet. If the actual flow to or from a reciprocating compressor cylinder were at a constant rate throughout the entire stroke of the compressor, then this method would be correct. This is not true because the rate of flow varies from zero to a maximum flow, and in any particular compressor cylinder varies with the conditions under which it is operating. For this reason the piping leading to and from most of the present compressor installations is too small, and in consequence the pressure drop between the compressor cylinder and the station header is greater than necessary. This condition necessitates a greater horsepower input to the compressor cylinder than normally would be used, and also reduces the capacity of the compressor, causing a twofold loss.

The proper method for calculating the correct pipe diameter to be used in connection with a reciprocating compressor should be based upon the actual flow conditions that are prevalent in these pipes. The actual momentary rates of flow must be known and an average of these rates, during the time the compressor is acting, should be used in calculating the pipe diameters. Momentary rate of flow at any point in the stroke of a compressor cylinder is found by multiplying the piston velocity in feet per minute at that point by the effective area of the compressor piston in square feet. If the momentary rates of flow at points throughout one

Fig. 1. (Below)—Graphical method of determining from an indicator card the average rate of flow
Fig. 2. (Right)—Rate of flow factor curves


PRESSURE
VOLUME
REGULAR COMPRESSOR INDICATOR CARD. A VOLUME-PRESSURE DIAGRAM. FULL LINES ARE VOLUME DIVISIONS. DASH LINES ARE TIME DIVISIONS.
ANGULAR DISPLACEMENT FOR EQUAL VOLUMES
ANGULAR DISPLACEMENT FOR EQUAL TIME INTERVALS
PRESSURE
TIME
REVISED INDICATOR CARD. A TIME-PRESSURE DIAGRAM. FULL LINES ARE TIME DIVISIONS. REPLOTTED ON A TIME BASIS FROM ABOVE CARD.
VELOCITY IN FPM
TIME
PISTON VELOCITY CURVE. A PLOT OF THE EQUATION,
$V = 60 R \omega \left[\sin \theta + \frac{C \sin 2\theta}{2\sqrt{1 - C^2 \sin^2 \theta}} \right]$
FLOW RATE IN CFM
TIME
MOMENTARY RATE OF FLOW CURVE FOR THAT PORTION OF THE STROKE DURING WHICH THE COMPRESSOR IS TAKING IN GAS AS SHOWN BY THE ABOVE INDICATOR CARD. THIS CURVE IS A PRODUCT OF THE PISTON AREA AND THE PISTON VELOCITY. THE DASH LINE IS THE AVE RATE AND IS THE AREA UNDER THE CURVE DIVIDED BY THE BASE OF THE CURVE.
FLOW RATE IN CFM
TIME
MOMENTARY RATE OF FLOW CURVE FOR THAT PORTION OF THE STROKE DURING WHICH THE COMPRESSOR IS DISCHARGING GAS AS SHOWN BY THE ABOVE INDICATOR CARD. THIS CURVE IS A PRODUCT OF THE PISTON AREA AND THE PISTON VELOCITY. THE DASH LINE IS THE AVE. RATE AND IS THE AREA UNDER THE CURVE DIVIDED BY THE BASE OF THE CURVE.


CURVE A
CURVE D
CURVE G
CURVE J
CURVE M
CURVE B
CURVE E
CURVE H
CURVE K
CURVE C
CURVE F
CURVE I
CURVE L
USE TOTAL PISTON DISPLACEMENT IN ALL CASES EXCEPT FOR SINGLE ACTING CYLINDERS WHERE TWICE THE PISTON DISPLACEMENT IS USED. DASH CURVE TO BE USED FOR FORWARD STROKE AND CURVE B FOR RETURN STROKE OF SINGLE ACTING CYLINDER.
RATE OF FLOW FACTOR CURVES
AVE. RATE OF FLOW=RATE FACTOR × PISTON DISPLACEMENT
VOLUMETRIC EFFICIENCY, E_v
AVERAGE RATE OF FLOW FACTOR

THE SEED FROM WHICH ALL INDUSTRY GROW

CHEMISTRY, the seed from which all industry grows, has written our world's history . . . It will record our future. Under the stimulus of war's insatiable demands for technical discovery and inventions, chemistry has revolutionized some of our basic industries. Most of these discoveries are common knowledge among normal rivals for the duration. But when the war ends, these new techniques will become the weapons of wide-open competition—under Free Private Enterprise.

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revolution of the crank, or two strokes of the compressor piston, are plotted the result will be a curve representing the momentary rate of flow for the compressor cylinder in question. From this curve the average momentary rate of flow for any portion of the stroke is obtained by averaging the part of the curve that represents that portion. The average momentary rate of flow, in cubic feet per minute, is then divided by the permissible gas velocity, in feet per minute, through these pipe lines and the result is the inside area of these pipe lines in square feet. In order to arrive at the average momentary rate of flow for any compressor cylinder the following data must be available: (1) bore and stroke of the cylinder; (2) speed at which the compressor operates; (3) relation between the crank and the connecting rod; (4) volumetric efficiency at suction conditions, and (5) volumetric efficiency at discharge conditions. The problem then can be solved graphically or algebraically.

Graphical Solution

A graphical solution is shown in Fig. 1. In the graphical solution an indicator card is taken from the cylinder in question and replotted on a time basis. The piston velocity curve based on the equation $V_p = 60R\omega$

$$\left[\sin\theta + \frac{C \sin 2\theta}{2(1-C^2 \sin^2\theta)^{1/2}}\right]$$

and shown on Fig. 1 need not be plotted, as it was shown only to visualize its relationship to the rate of flow curves.

TABLE I

Part of stroke	Forward stroke				Return stroke				Part of stroke
	Crank angle	Piston velocity	Mom. rate of flow	Ave.mom. rate flow	Crank angle	Piston velocity	Mom. rate of flow	Ave.mom. rate flow	
0.00	0.00	0.0	0.00	0.00	180.00	0.0	0.00	0.00	0.00
0.05	23.63	149.1	74.55	38.09	208.83	127.6	63.80	31.22	0.05
0.10	33.79	203.9	101.95	82.27	220.78	173.8	86.90	44.14	0.10
0.15	41.86	241.0	120.50	64.50	230.15	213.0	106.50	53.84	0.15
0.20	48.92	268.2	134.10	73.59	238.18	238.5	119.25	61.88	0.20
0.25	55.38	288.2	144.10	81.26	245.73	261.3	130.65	68.84	0.25
0.30	61.46	302.9	151.45	87.86	252.02	280.0	140.00	74.98	0.30
0.35	67.30	312.7	156.35	93.61	258.28	295.0	147.50	80.48	0.35
0.40	73.00	318.3	159.15	98.63	264.26	306.2	153.10	85.45	0.40
0.45	78.64	320.2	160.10	103.00	270.06	314.0	157.00	89.94	0.45
0.50	84.26	319.9	159.95	106.81	275.74	319.9	159.95	94.00	0.50
0.55	89.94	314.0	157.00	110.07	281.36	320.2	160.10	97.67	0.55
0.60	95.74	306.2	153.10	112.81	287.00	318.3	159.15	100.94	0.60
0.65	101.74	295.0	147.50	115.02	292.70	312.7	156.35	103.82	0.65
0.70	107.98	280.0	140.00	116.69	298.54	302.9	151.45	106.30	0.70
0.75	114.63	261.3	130 65	117.77	304.62	288.2	144.10	108.33	0.75
0.80	121.82	238.5	119.25	118.21	311.08	268.2	134.10	109.86	0.80
0.85	129.85	213.0	106.50	117.83	318.14	241.0	120.50	110 76	0.85
0.90	139.22	173.8	86.90	116.36	326.21	203.9	101.95	110.80	0.90
0.95	151.17	127.6	63.80	113.12	336.37	149.1	74.55	109.36	0.95
1.00	180.00	0.0	0.00	100.00	360.00	0.0	0.11	100.00	1.00

Based on crank to connecting rod ratio = 1 to 5. Stroke = 1A.
Effective piston area = 0.5 sq. ft. Speed = 100 r.p.m.
Piston displacement = 100 cu. ft. per min.

The momentary rate of flow curve is then plotted using the piston velocities given in Table 1 at distances stepped off on the base line of this curve equivalent to parts of the stroke in time until the volumetric efficiency at suction conditions is reached. The area between a vertical line erected at this point and the end of the stroke is obtained with a planimeter and this area divided by the distance from the vertical line to the end of the stroke is the average momentary rate of flow for the cylinder under suction conditions. The same method is used for discharge conditions, only in this case the distance stepped off on the base line is equivalent to the volumetric efficiency at discharge conditions.

Algebraic Solution

The algebraic solution begins with the solution of the piston travel equation:

$$S = (L_c + R) - L_c(1 - C^2\sin^2\theta)^{1/2} - R\cos\theta.$$

The values of S corresponding to pertinent crank angles are given on Table 1. The crank angle corresponding to the volumetric efficiency is found and this angle divided by 180 and multiplied by the time of one stroke, gives the time that the gas is flowing to or from the compressor cylinder depending upon whether the suction or discharge volumetric efficiency is used. The amount of gas moved during this time is equal to the piston displacement of the compressor cylinder for one stroke multiplied by the volumetric efficiency. This amount divided by the time during which the gas was flowing will result in the aver-

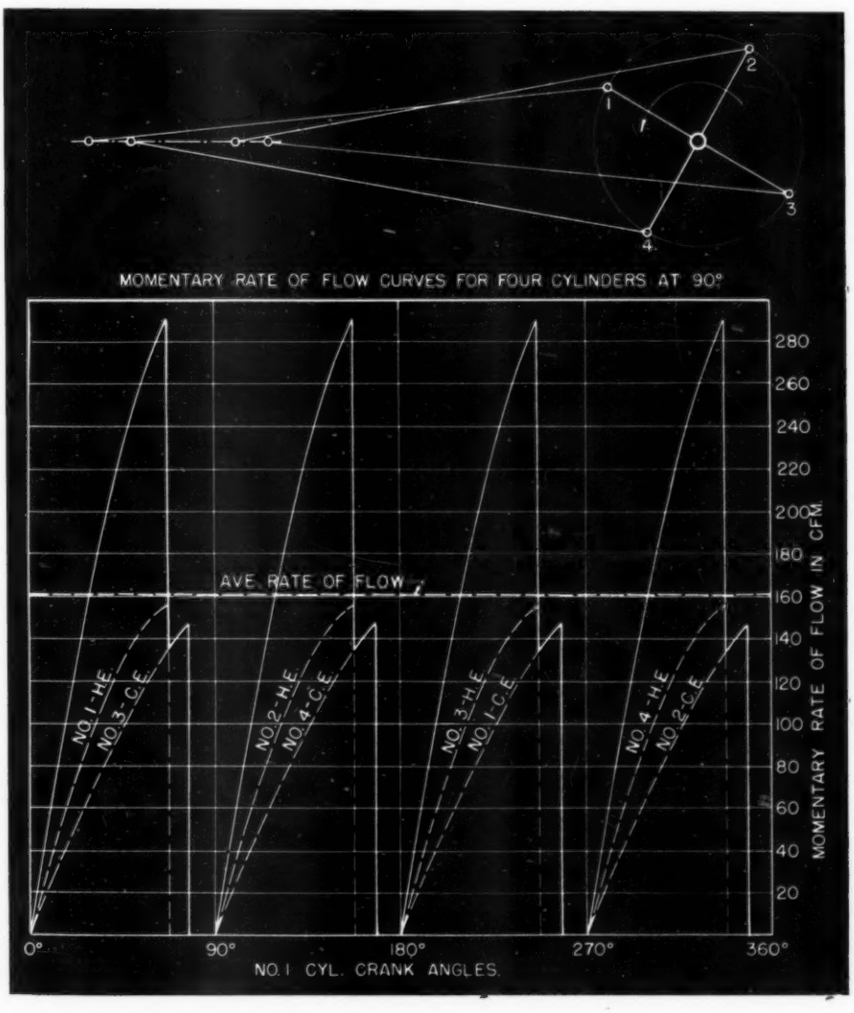

Fig. 3. Graphical solution for average rate of flow for four cylinders of the same piston displacement operating at 90° from each other

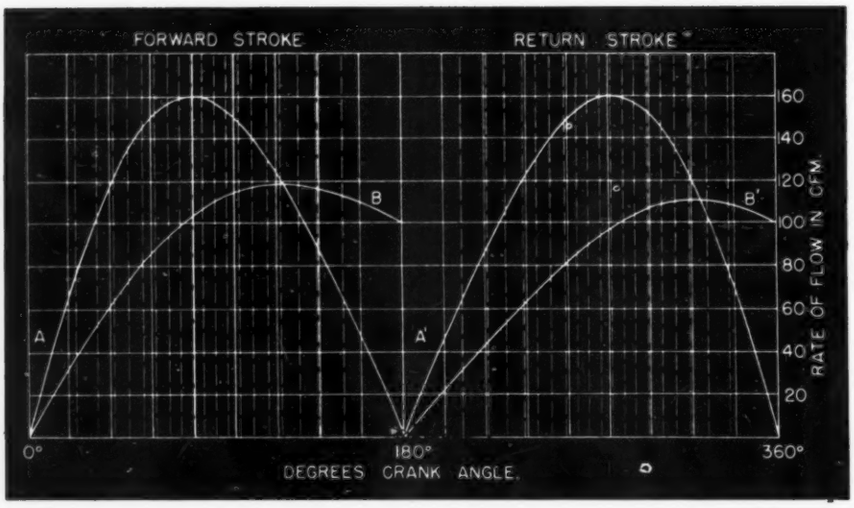

Fig. 4. When the cylinder is single acting, the curve of the average rate of flow is not the same on the forward stroke as on the return stroke

age momentary rate for the cylinder during the suction or discharge stroke depending upon the volumetric efficiency taken.

Rate Factor Curve

In order to free the designer from all this burdensome graphical analysis or calculation, a rate factor curve has been prepared. This curve, Fig. 2, is based on a double acting compressor cylinder having a crank rod ratio of 1 to 5. This ratio was chosen because it is closer to the present-day American practice. Using this curve requires that only the volumetric efficiency and the piston displacement of the cylinder be known. The rate factor corresponding to the volumetric efficiency is found and multiplied by the piston displacement giving the average rate of flow in cubic feet per minute. For single acting compressors the rate factor must be multiplied by twice the piston displacement to arrive at the correct average rate of flow.

When two or more cylinders take suction from or discharge into the same pipe line the average rate of flow for this group of cylinders is not the summation of each of their average rates of flow. In this case the solution for the average rate of flow for the group can be either graphical or algebraic. The graphical solution is better because it shows the maximum and minimum rates of flow during the time gas is flowing to or from the compressor cylinder. Fig. 3 shows a graphical solution for the average rate of flow for four cylinders of the same piston displacement operating at 90° from each other. The discharge volumetric efficiency is taken at 35 percent for all cylinders and rate of flow curves are plotted for each cylinder in its proper position in the stroke. The ordinates for these curves are then added and the total flow curve plotted from these additions. After finding the area of the total flow curve with a planimeter this area is divided by the base of these curves, which corresponds to the length of time the gas is flowing, and the result is the average rate of flow for this condition. It can be seen from this curve that in this case the average rate of flow is 161 cu. ft. per min. and that the maximum rate of flow is 290 cu. ft. per min. The compressors are taking in or discharging gas for 87 percent of a revolution and during 49 percent of this time the rate of flow is greater than the average rate of flow. This gives the designer a clearer picture of the flow to or from the compressor cylinder than the conventional algebraic solution.

When a single acting cylinder is used the curve of the average rate of flow is not the same on the forward stroke as on the return stroke. This is due to the effect of the connecting rod and is shown on Fig. 4. The curves A and A′ are the momentary rate of flow curves for the forward and return strokes respectively and the curves B and B′ are the corresponding average rate of flow curves. The dash line vertical divisions represent the parts of a stroke or the volumetric efficiencies plotted on a time or crank angle basis. The points for the B curves are found graphically as explained previously. Fig. 5 is a replot of the B curves using a volume base instead of a time base as in Fig. 4 and the vertical divisions are given as a factor of the piston displacement. This is done to make the curves more applicable for engineering use. In both curves it can be seen that the average rate for the forward stroke is considerably greater than that for the return stroke. This is due to the effect of the connecting rod and if the driving mechanism for the compressor cylinder in question has a much different crank to connecting rod ratio than 1 to 5 it will be well to recalculate the curves given in this article as all curves and calculations are based on this ratio.

Returning to Fig. 2 the dash line curve is the rate factor curve for the forward stroke of a single acting compressor and is the same as the forward stroke curve of Fig. 5 plotted to a different scale and the curve B in Fig. 2 is the same as the return stroke of a single acting compressor. The curve B is also the rate factor curve for two double acting compressor cylinders with their cranks at 180° from each other. When using the factor for a single acting cylinder the factor is multiplied by twice the piston displacement of the single acting cylinders whereas when using the factor for two double acting cylinders the rate factor is multiplied by twice the piston displacement of the double acting cylinders. In all cases Fig. 2 can only be used when the compressor cylinders mounted on the unit in question are identical or have the same piston displacement and the same volu-

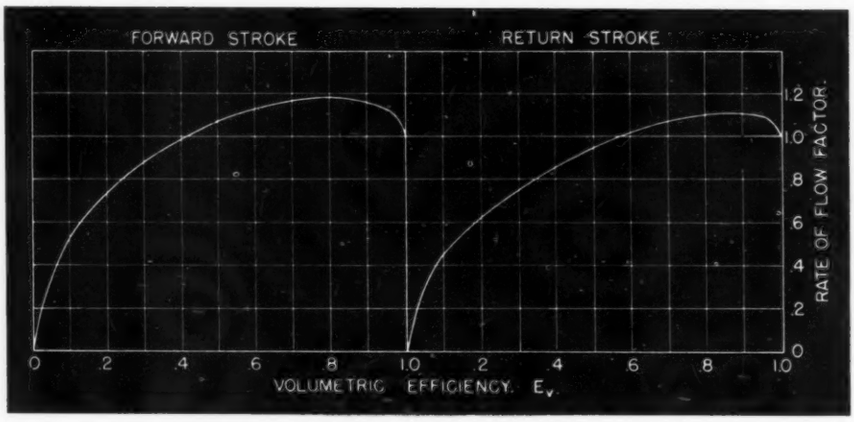

Fig. 5. Replot of the B curves in Fig. 4 using a volume base instead of a time base, and the vertical divisions are given as a factor of the piston displacement

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metric efficiencies. It can be seen from Fig. 2 that the greater the number of cylinders, the earlier in the stroke is the average rate of flow factor equal to the volumetric efficiency. This does not mean that the flow is constant but is a statement that the average of the peaks and depressions in the momentary rate of flow curve is equal to the volumetric efficiency.

Although the foregoing method of arriving at the average rate of flow to or from a compressor cylinder does not take into consideration the maximum or minimum rates of flow that are the producers of pipe line pulsations, the writer believes that it gives a more accurate picture of what actually is occurring in the pipe line than the method based upon the capacity of the compressor cylinder.

As stated previously, the average rate of flow divided by the permissible gas velocity gives the internal area of the pipe to be used. The permissible gas velocity should be so chosen that the pressure drop in the pipe does not affect the normal operation of the compressor cylinder. Obviously, a small pressure drop in the suction line of a vacuum cylinder will have considerably more effect on the capacity and horsepower consumed than it would upon a cylinder operating at high pressures. Therefore it is thought that the drop in pressure between a station header and the compressor cylinder drawing from it, of 0.05 percent of the header pressure, be used as the maximum drop. This allows the use of Fanning's equation:

$$\Delta P = \frac{0.000001439 f L_p V_g^2 \rho}{d}$$

which can be transposed to

$$V_g^2 = \frac{\Delta P d}{0.000001439 f L_p \rho}$$ and thus give an easy solution for the allowable velocity. Fig. 6 is a plot of Fanning's equation when ρ is 0.049719 lb. per cu. ft., which is the value for 0.65 gravity natural gas at 60°F. and 30 in. Hg. μ in the Reynolds number equation $N_r = \frac{dV_g\rho}{720\mu}$ is taken as 0.0000067205 lb. per ft-sec., which is a fair average of the viscosity of natural gas at 60°F. This plot enables one to arrive at the pressure drop ΔP through 100 ft. of line without solving Fanning's equation. Should the gas flowing be of a different density, ΔP can be corrected for this density by multiplying the curve result by the new density divided by 0.04972. Any other length than 100 ft. will change the ΔP in direct proportion of the new length to 100 ft. This plot also shows the gas velocity lines and the Reynold's number lines. The above formulae and curves should enable anyone to calculate the piping to and from a compressor in any compressor station.

Symbols Used

C = crank to connecting rod ratio = R/L_c,
D = internal diameter of pipe, ft.,
d = internal diameter of pipe, in.,
f = Fanning friction factor = $0.0035 + 0.264\left(\frac{1}{N_r}\right)^{0.42}$ for commercial iron and steel pipes,
G = mass velocity, lb. per sq. ft-sec.,
L_c = length of connecting rod, ft.,
L_p = length of pipe, ft.,
N_r = Reynold's number = $\frac{DG}{\mu} = \frac{dV_g\rho}{720\mu}$,
ΔP = pressure drop, lb. per sq. in.,
R = crank radius, ft.,
S = piston movement from dead center, ft.,
V_g = linear gas velocity, ft. per min.,
V_p = piston velocity, ft. per min.,
μ = absolute viscosity, lb. per ft-sec.,
ρ = density of gas, lb. per cu. ft.,
θ = crank angle in degrees, and
ω = angular displacement of crank pin in radians per sec.

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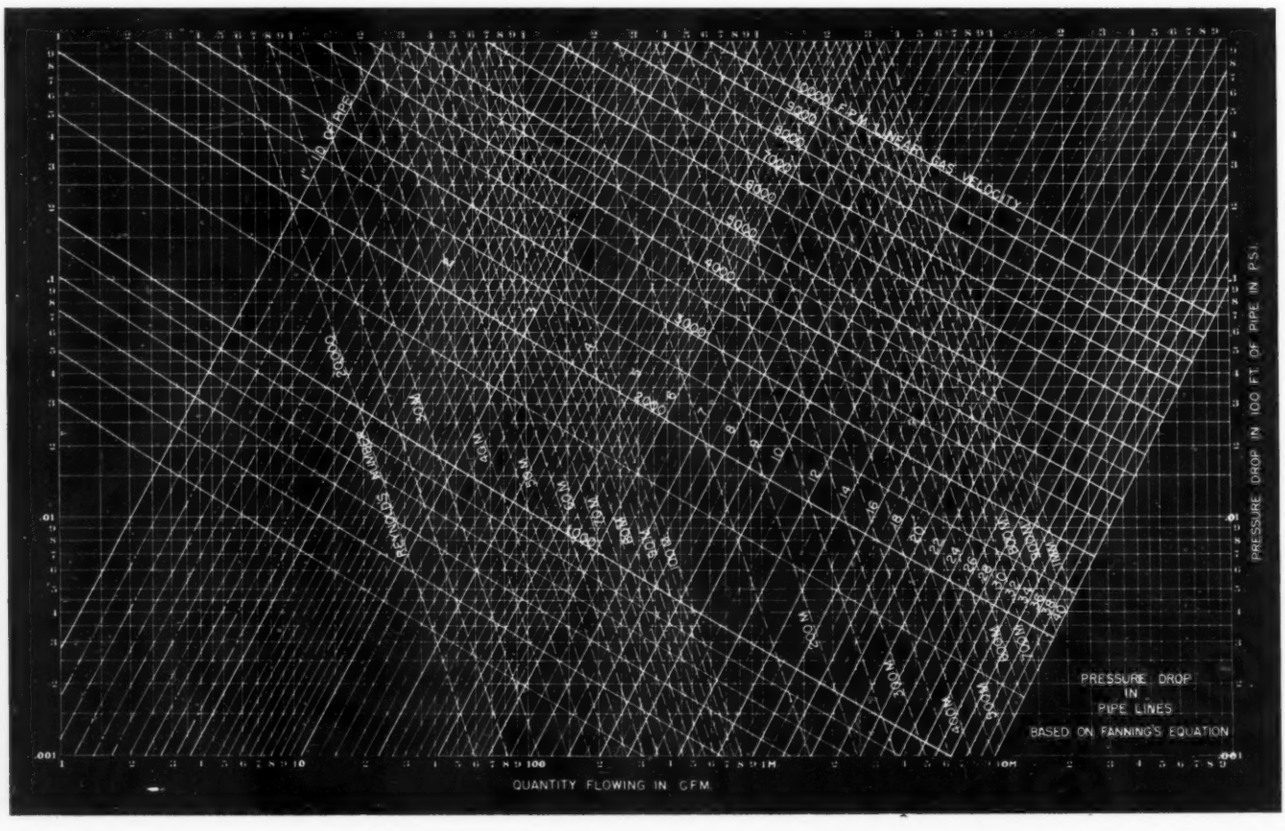
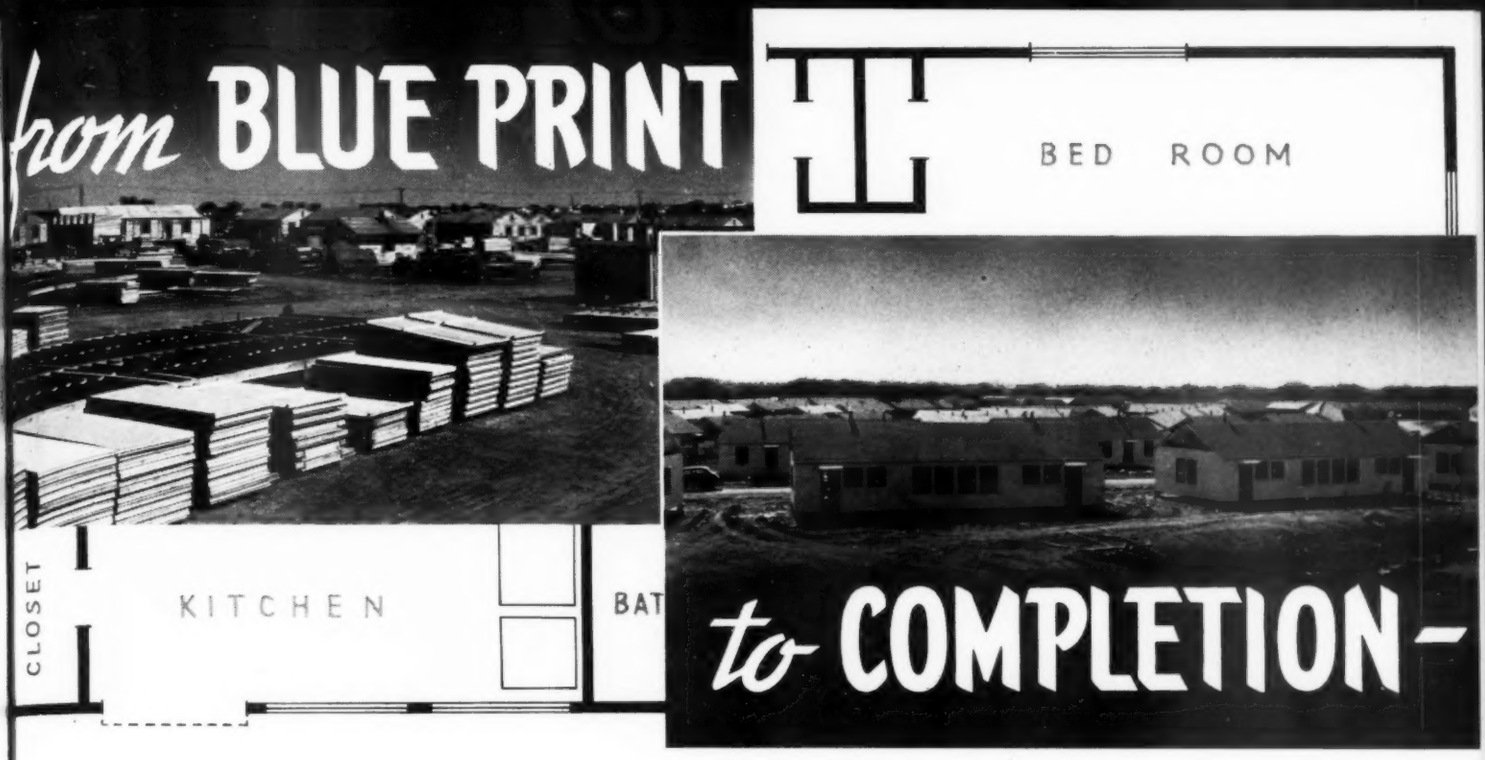
Fig. 6. Pressure drop in pipe lines based on Fanning's equation


PRESSURE DROP IN PIPE LINES BASED ON FANNING'S EQUATION
QUANTITY FLOWING IN C.F.M.
PRESSURE DROP IN 100 FT. OF PIPE IN P.S.I.
REYNOLDS NUMBERS
LINEAR GAS VELOCITY



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Installing Air Compressor Equipment[1]

☆ Proper engineering results in full efficiency of unit

INASMUCH as the air compressor is usually integrated with the plant, shop, or building structure and forms a part of the overall facilities, the job of installation is properly classified as engineering.

Engineering a compressor installation is, therefore, a particularly important step. Properly done, there need be no concern about the efficiency built into the equipment by the manufacturer. The first consideration is the exact location of the compressor. Where should it be installed to insure best performance? A compressor needs a clean, light room, with ample space around it for normal cleaning and inspection. Under certain conditions, pistons must be removed and there should be ample room for doing this job right. Space is also required for removing the intercooler tube when more than one stage compression is being developed.

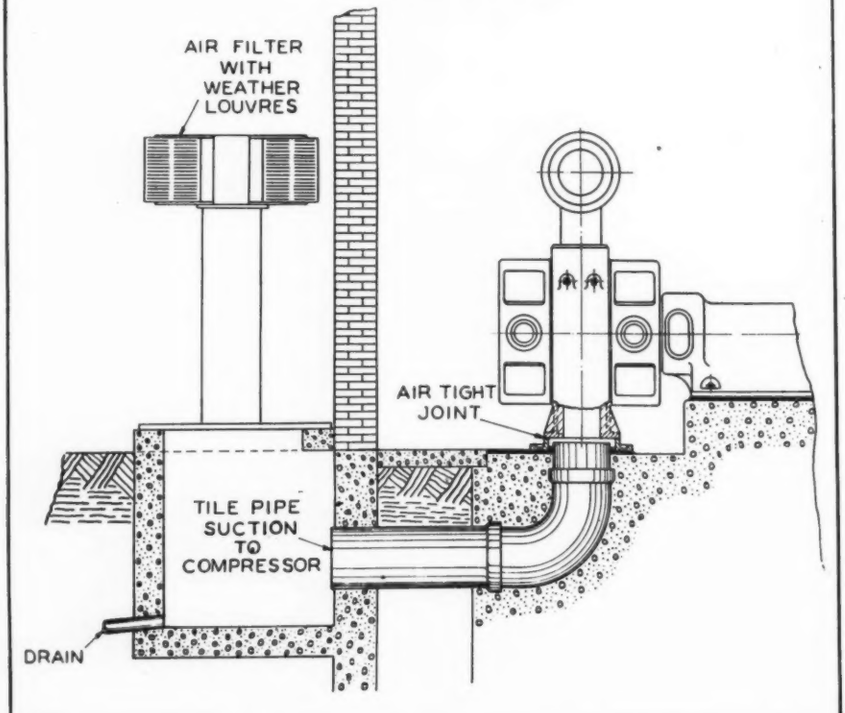
The intake must be clear of any exhaust pipe, whether for steam, water, fuel oil, dust, or other waste. Air currents may reasonably carry such exhausts into the compressor and through the pipes to the air-driven tools and other compressed air equipment. For installations in plants that create dust, fumes, and other suspended particles, the compressor should be situated in a dust-tight enclosure or in the engine room with provision made for drawing clean air from the outside. Air intakes will be discussed in greater detail later in this article.

The importance of properly locating the compressor brings into sharp focus the need for its inclusion in new plant construction plans. The designing of structures to house manufacturing equipment will be adequate only to the degree that all factors are considered as a related whole—and it is certainly a recognized fact that facilities for compressed air should be considered wherever past experience in similar production problems prove the better performance of this type of power. Even without the benefit of previous examples in related production, there is abundant evidence of compressed air's versatility which, when properly translated for new applications, will add materially to operating efficiency. The Compressed Air Institute will make available practical help along these lines to anyone faced with new production problems.

For the present discussion on compressor installations, attention is directed to stationary compressors of all types. Portable and special type compressors must be considered according to individual requirements.

[1]Courtesy Compressed Air Institute, Cleveland, Ohio.

Fig 1. Cross-section of intake



Foundation

Whether for a new structure, which includes properly allotted space for the compressor, or for the addition of compressed air facilities to present equipment, all recognized manufacturers of standard compressors regularly supply drawings of required foundation of appropriate mass and base area for good subsoil such as hard, dry clay or hard, dry clay mixed with gravel (hard pan), or coarse, dry gravel, generally specifying a certain concrete mixture, such as 1:2:4 ratio, the concrete to be poured while its temperature is between 40° and 120°F. Variations of recommended mixtures are permissible when suitable substitutes are available locally, but the proportion of high-grade Portland cement to the aggregate should not be reduced. In all cases the foundation should be carried to a depth below the frost line, which should not be assumed but accurately determined by climatic experience.

When there is doubt regarding the character of the subsoil, borings should be made at the proposed compressor location and judged by a competent foundation contractor, who will, in turn, make recommendations regarding foundation materials. Obviously, the compressor manufacturer cannot assume responsibility on this account. Extremely weak subsoil—water bearing, for example—may require piles to support the mat, with braces to resist horizontal displacement.

Both foundation block and mat should be cast in single pours, with anchors of vertical bars, or poured together. Ten days for curing should be allowed before erection of the compressor is begun. Sprinkling the concrete with water and covering with straw, burlap, or sand will improve this curing.

To avoid transmission of vibration, walls and floors of the compressor room should be insulated from the foundation by a narrow gap adjacent to the room floor and filled with asphalt or other insulation material.

If the plant is without a basement,

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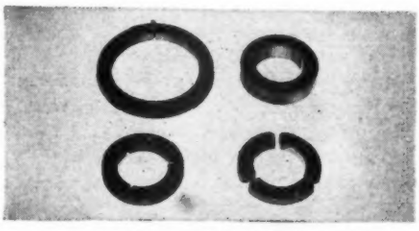
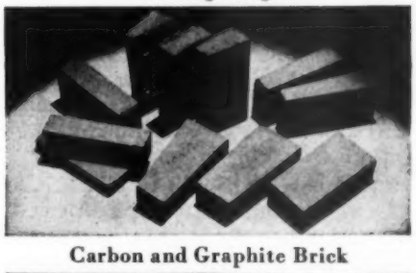


Packing and Seal Rings



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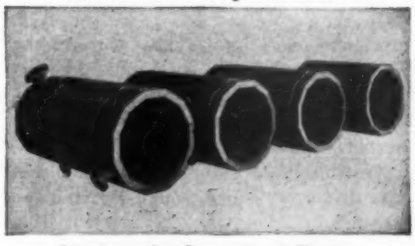
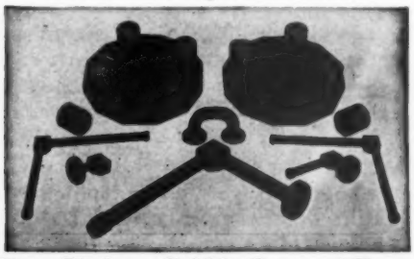


Sections for Segmental Tower



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proper provision must be made for laying pipe so that all flanges, valves, unions, and joints will be accessible. To minimize the number of pipe trenches, complete piping layout should be made prior to installation. This will not only add to the appearance of the foundation but will materially affect the accessibility and otherwise improve the operation and maintenance of the plant.

Air Intake

Brief mention has already been made of air intakes. In addition to avoiding discomfort for the air tool operator as a result of fumes, gases, and dust, clean air has another basic advantage, as it is logically found in cool areas. An actual increase in delivery of 1 percent is gained for every 5° reduction in intake temperature, as the density of air varies inversely as its absolute temperature. (See Table 1.)

To extend the intake into the air outside the compressor room or place it a reasonable distance from the plant—wherever the air is cleaner and cooler—is an important phase of engineering a compressor installation. For greatest efficiency, however, the intake piping should be as short and direct as possible, using long radius elbows when bends are necessary. It should be the full diameter of the intake opening of the air cylinder or, if longer than 12 ft., the next larger size pipe should be used.

When clean air is not constant because of local conditions—smoke, fumes, etc.—an air filter should be attached to the air intake pipe. A typical air intake installation with filter is shown in Fig. 1. Objectionable noise from the air intake suction can be minimized by one of the many standard air silencers available for that purpose.

For above-the-floor intake pipe, it is best to use standard steel or sheet metal pipe. Underground intakes can be constructed of glazed vitrified sewer pipe, but care should be taken to seal all joints with cement to make them water tight against possible seepage and ground moisture. In all intake installations it is important for interior surfaces to be smooth and hard, to prevent any disintegration from being carried into the compressor cylinder, which would cause rapid wear. Painting the interior of a concrete duct with good water-proof paint is advisable.

Unusual conditions, such as near-by chemical plants, should be considered as special problems and should be discussed with a reliable compressor manufacturer for proper solution.

Before starting a compressor, the entire suction line should be thoroughly cleaned to remove pipe scale, sand, grit, or other foreign matter accumulated during installation. Many compressors are seriously damaged by drawing through the machine dirt and foreign matter from the intake piping.

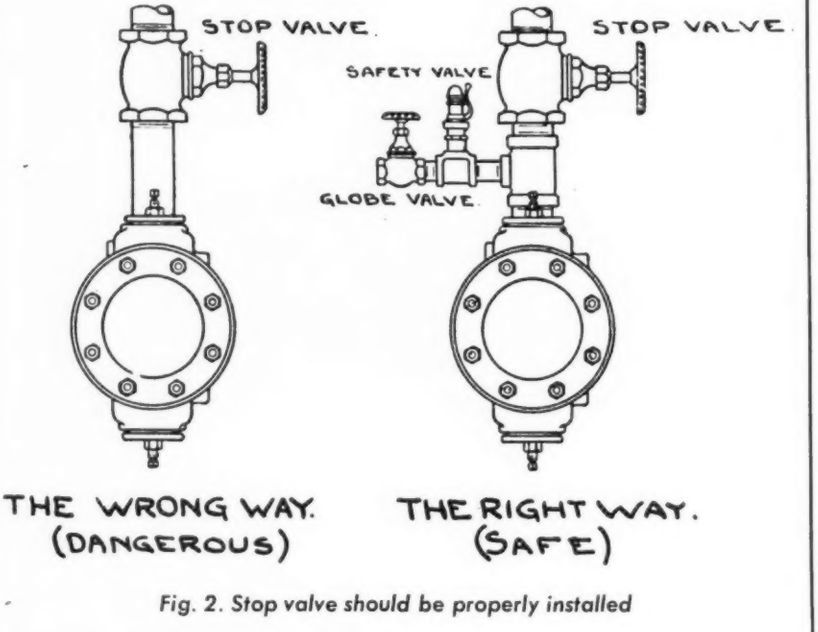


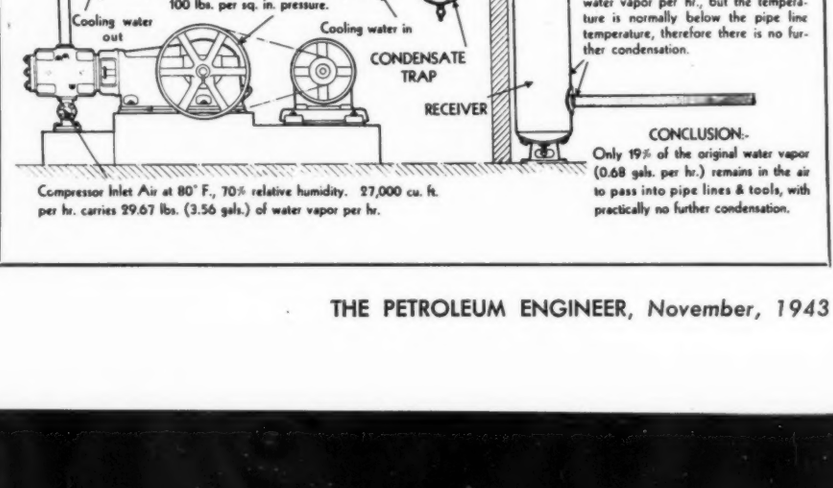
Fig. 2. Stop valve should be properly installed

Air Discharge Piping

Discharge piping should not be smaller than the full size of the discharge opening and should run directly to an aftercooler if one is used. If no aftercooler is used this pipe should be attached directly to the air receiver, the latter to be set outdoors if possible, but as close to the compressor as practicable. Straight lines are desirable. Long radius elbows should be used when bends are necessary. When pockets are unavoidable because of required bends, there should be a drain valve or trap to prevent accumulation of oil. As the discharge line is hot, contact with wood or combustible material should be avoided. Flanged fittings or unions should connect the discharge pipe to the cylinder to permit removal of the cylinder without disturbing the piping. Always support and anchor overhead pipe to relieve cylinders of incidental strains, and avoid vibration of piping resulting from pulsating discharge of the compressor.

Traps are necessary at frequent intervals if compressed air uses are intermittent and cooling periods allow moisture to precipitate. There is little opportunity for the compressed air to cool by radiation and an aftercooler is therefore necessary to cool the air and precipitate moisture before it enters the power line. Small air receivers are often

Fig. 3. Proper piping installation showing location of "pipe line" aftercooler


Air discharged from compressor at 360° F
Contains 29.67 lbs. (3.56 gals.) of water vapor per hr.
Aftercooler
COMPRESSOR
450 c.f.m. Actual Free Air Delivery at 100 lbs. per sq. in. pressure.
Cooling water out
Cooling water in
CONDENSATE TRAP
RECEIVER
81% of the original water vapor c.. 2.88 gals. per hr. has been condensed by the aftercooler. Discharge air, cooled to 80° F., now contains only 5.67 lbs. (0.68 gals.) water vapor per hr.
80 F. Air at the Receiver and in the pipe lines contains 5.67 lbs. (0.68 gals.) water vapor per hr., but the temperature is normally below the pipe line temperature, therefore there is no further condensation.
CONCLUSION:-
Only 19% of the original water vapor (0.68 gals. per hr.) remains in the air to pass into pipe lines & tools, with practically no further condensation.
Compressor Inlet Air at 80° F., 70% relative humidity. 27,000 cu. ft. per hr. carries 29.67 lbs. (3.56 gals.) of water vapor per hr.

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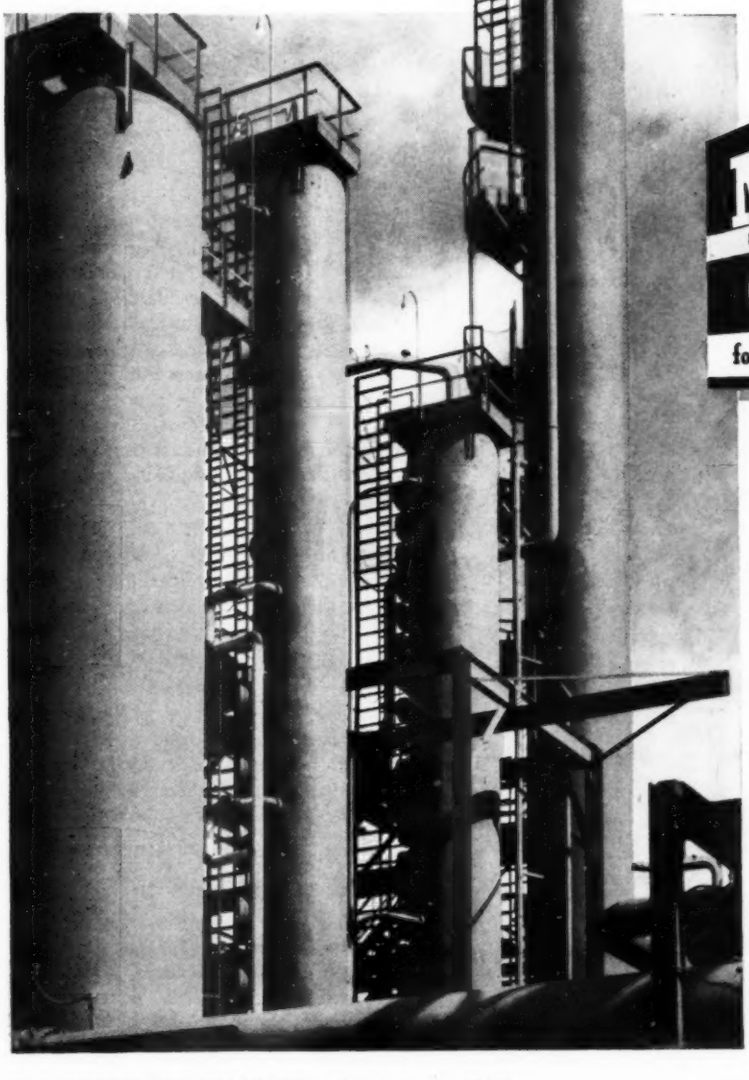

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TABLE I

Effect of initial or intake temperature on delivery of air compressors

Initial temperatures		Relative delivery	Initial temperatures		Relative delivery
°F.	Degrees absolute F.		°F.	Degrees absolute F.	
−20	440	1.18	70	530	0.980
−10	450	1.155	80	540	0.961
0	460	1.13	90	550	0.944
10	470	1.104	100	560	0.928
20	480	1.083	110	570	0.912
30	490	1.061	120	580	0.896
32	492	1.058	130	590	0.880
40	500	1.040	140	600	0.866
50	510	1.020	150	610	0.852
60	520	1.00	160	620	0.838

put in the lines at frequent intervals to act as collecting tanks when an aftercooler is not employed. Proper piping must be installed to permit draining of these vessels regularly, and a daily schedule of draining established.

All air hose connections should be made at the top of distributing lines to avoid picking up moisture.

When more than one compressor discharges into a single aftercooler or receiver, a globe or gate valve may be placed in the discharge line, but in this instance a safety valve positively must be placed in the line between the cylinder and the shut-off valve. Without this safety valve, a closed gate valve would soon build up dangerous pressure when the compressor is started. (See Fig. 2). The safety valve should have a total capacity sufficient to accommodate the entire output of the compressor. Proper arrangement of piping is shown in Fig. 3.

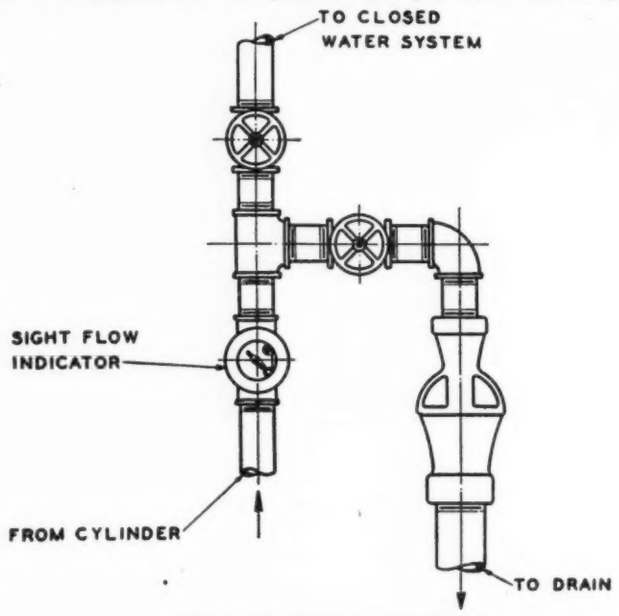
Circulation Water

Provisions for cooling water must take into consideration the importance of circulating only clean water, as the use of dirty water clogs the water jackets, cylinder heads, and intercoolers and reduces cooling efficiency. If the available cooling water is very cold it should first be passed through the intercooler to increase the temperature and thus avoid condensation in the inlet passage of the high-pressure cylinder. Such condensation would be carried into the air cylinder and destroy the lubricant, causing rapid cylinder wear.

The use of a closed, or thermo-syphon cooling system, is not recommended except in cases where circulating water is not available. When a closed system is installed, sight-flow indicators should be placed on the water discharge lines from each cylinder and the intercooler to show positively that the water is being circulated. Fig. 4 shows how water piping should be arranged when a closed system is used. The efficiency of an open cooling system can be measured at the water discharge.

Engineering a steam-drive compressor installation obviously involves factors common to the steam engine, such as slant of steam pipe toward the compressors to avoid low spots or pockets where water can accumulate and be carried into the steam cylinder. The importance of insulating live steam pipes properly should not be overlooked. Steam separators are always advisable and necessary if the compressor is some distance from the boiler. This, in addition to being a safety measure, also insures drier steam. A stop valve placed at the point where the steam pipe branches from the main line is important for making repairs, repacking, or regrinding the throttle valve. This stop valve could also be used to shut down the compressor in case the throttle valve is inoperative.

Fig. 4. Arrangement of air cylinder water piping for closed system



ARRANGEMENT OF AIR CYLINDER WATER PIPING WHEN CLOSED SYSTEM IS USED.

"Stripper Wells to Go"

Governor Andrew Schoeppel of Kansas has predicted that "close to 13,000 oil wells" in the Mid-Continent area will be abandoned in the next few months if the present trend continues. Price of crude oil, he said, is not high enough to permit independent operators to make a profit on stripper wells.

Steam Exhausts

Steam exhaust piping should be laid beneath the floor and then vertically to atmosphere. If a condenser is used, the main exhaust pipe will be connected to it, but there should also be an opening to atmosphere provided by a relief valve. Exhaust piping should drain toward the condenser, and should be as short as possible.

The selection of belts for motor-driven or steam-engine belt-drive compressors should be based both on good quality and the sound engineering of pulley relationship. Belt performance on air compressor installations is based upon the same principles as for any other belt transmission of power. Compressor manufacturers supply proper specifications based on successful experience. The use of multiple V-belts is popular practice and such a well-designed drive can be fully recommended.

In a broad sense, the proper engineering of a compressor installation will give greater assurance of dependable air power for the applications of compressed air that are already in use and help materially to increase productive capacity through new uses.

The war effort has wrought many changes in production methods, but none is more striking than the increased use of compressed air. The efficiency of equipment designed to utilize compressed air, however, can only be as effective as the ability of the compressor to deliver the power needed to operate it.

To engineer a compressor installation is to fix its efficiency according to the intent of its manufacturer. It need not fall below that standard.

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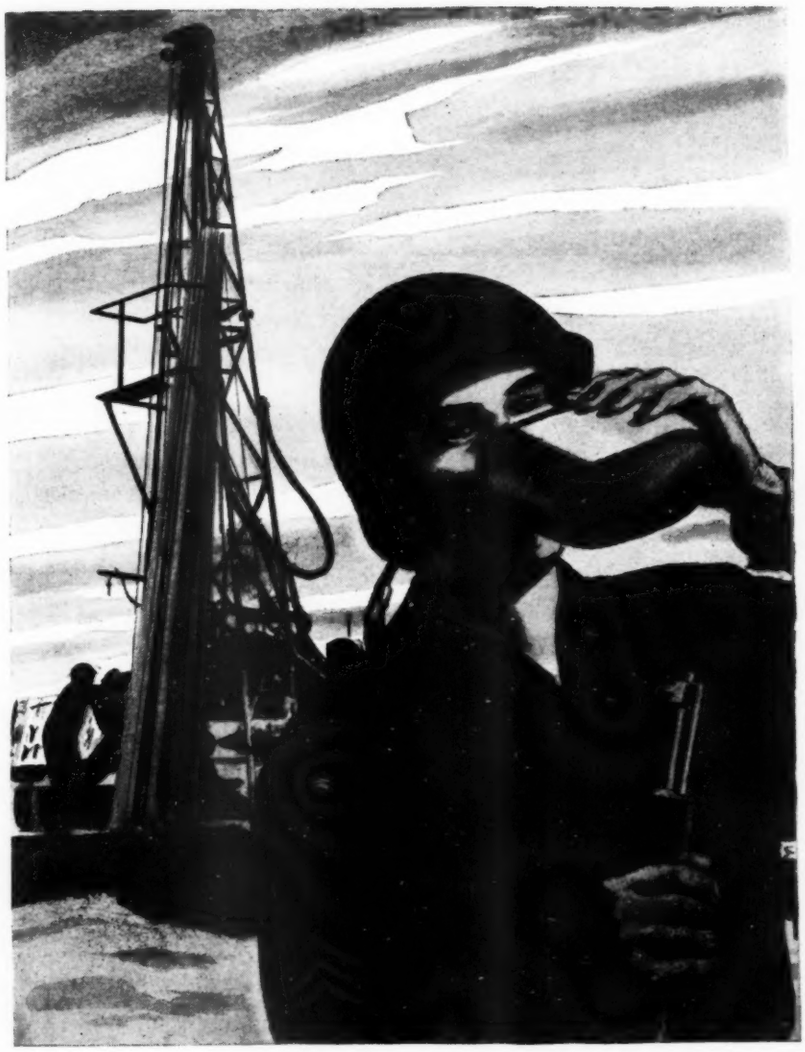

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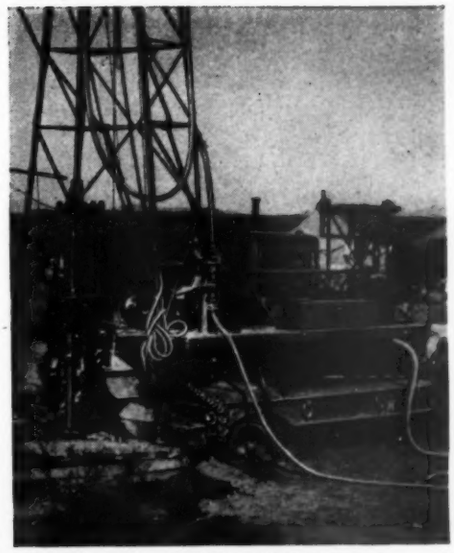

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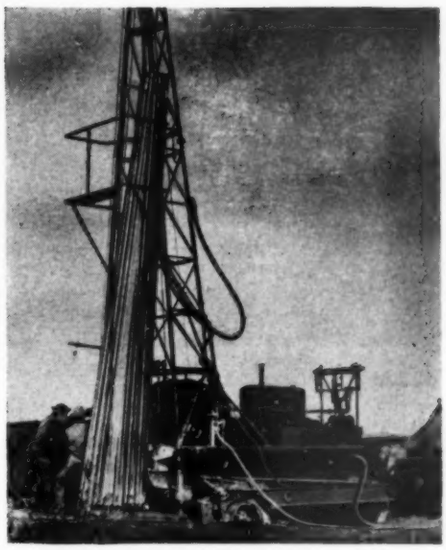

THE FIVE DISTINCT TYPES of United States Rubber Company hose supplied for the combat-zone drill rig are: high-pressure rotary hose; mud-suction hose, capable of being re-shaped if crushed; light, strong, wash-down water hose; high-pressure hose for hydraulic controls; oil suction hose for hydraulic system. These hose, as well as the special rubber valves and packings also supplied by the United States Rubber Company, are all specially designed to get water fast and to be tough for front line service.

United States Rubber Company engineers have aided many manufacturers in their problems of supplying articles of rubber for direct warfare use by the Armed Forces . . . as well as rubber equipment for plant production, safety and protection uses.

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The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions at the rate of $3.00 a year, or $4.00 for two years. General field classification numbers are as follows:

Nos. P000-P399—General

Nos. P400-P-499—Drilling

Nos. P500-P599—Production

Nos. P600-P699—Transportation and storage (includes pipe line)

Nos. P700-P799—Refining, including

Nos. P770-P799—Natural Gasoline, which may be classified in a separate division as shown here if of special interest to the user

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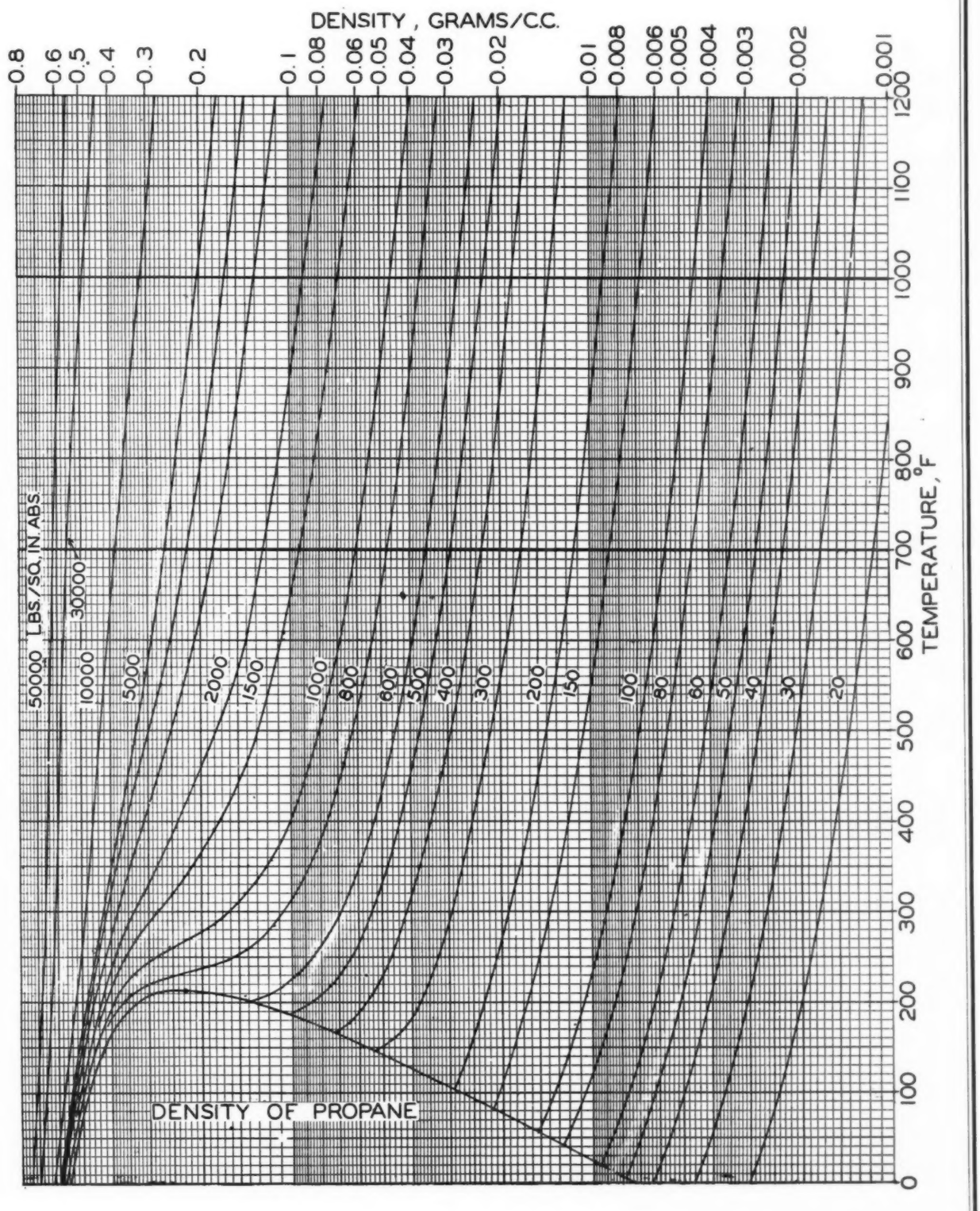
DENSITY OF PROPANE



—Chart by George Granger Brown, University of Michigan.

THESE "*Twins*" ARE POPULAR IN SYNTHETIC RUBBER PLANTS

General view of a representative synthetic rubber plant, with close-up of some of the TWIN G-FIN SECTIONS used in the plant

Here is an industry that produces an urgent war-time necessity . . . synthetic rubber. Only PROVEN equipment can be used . . . delays for readjustments, repairs, replacements, would be too costly in vital time.

This is one of the reasons why TWIN G-FIN SECTIONS have been selected to handle important heat transfer processes in many synthetic rubber plants . . . for these units had previously PROVEN their effectiveness, reliability, durability, in tens of thousands of installations . . . for periods as long as ten years.

Many other industries, too, know the advantages of TWIN G-FIN SECTIONS . . . the "Universal Heat Exchanger" . . . used on a greater variety of services than any other design of heat transfer apparatus on the market.

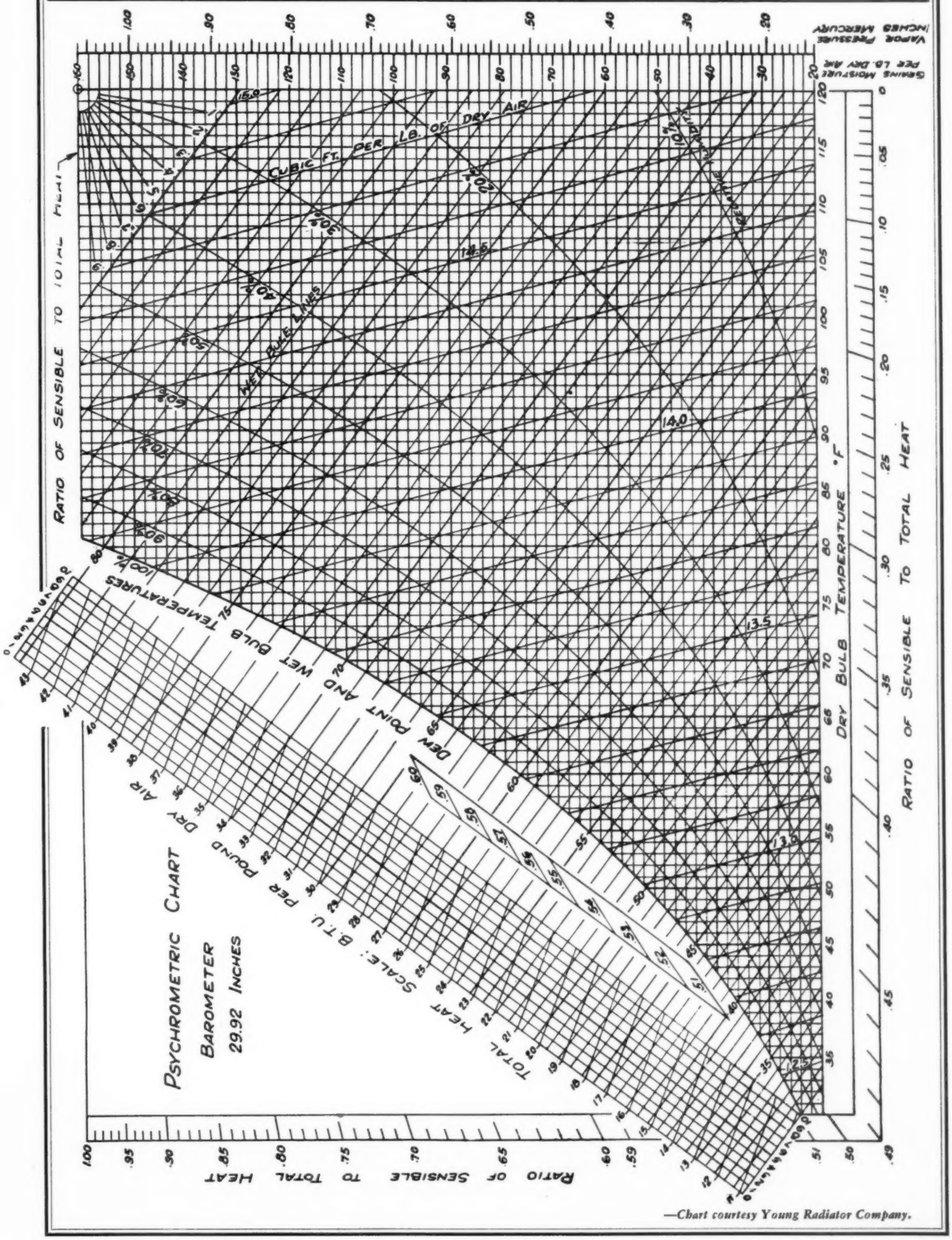
The whole TWIN G-FIN SECTION story is in our Bulletin 1613 . . write for your copy today.

THE GRISCOM-RUSSELL CO.

285 MADISON AVENUE **NEW YORK 17, N. Y.**

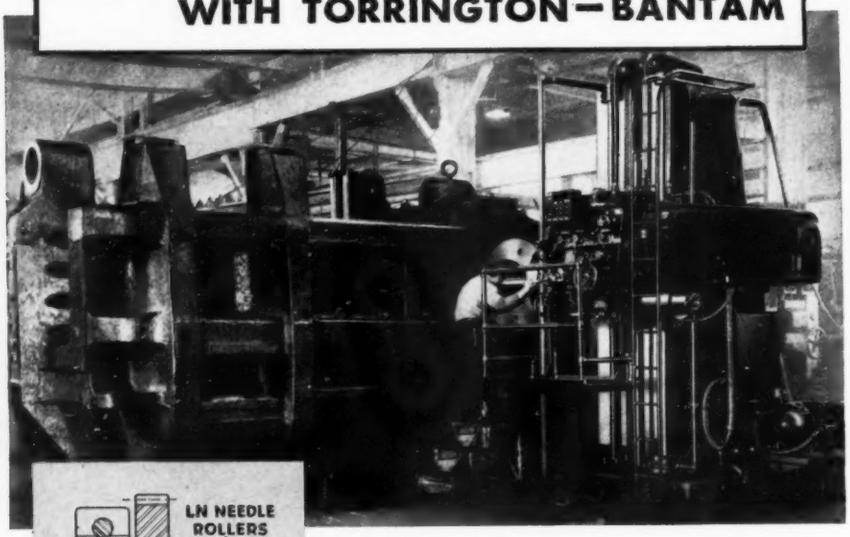
GRISCOM-RUSSELL
TWIN G-FIN SECTION
The Universal Heat Exchanger

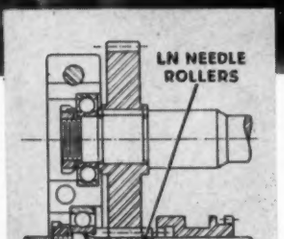
PSYCHROMETRIC CHART



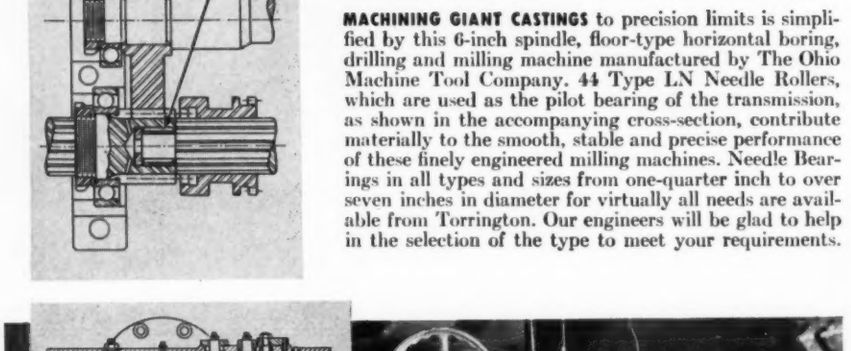
—Chart courtesy Young Radiator Company.

IN THE NEWS
WITH TORRINGTON—BANTAM

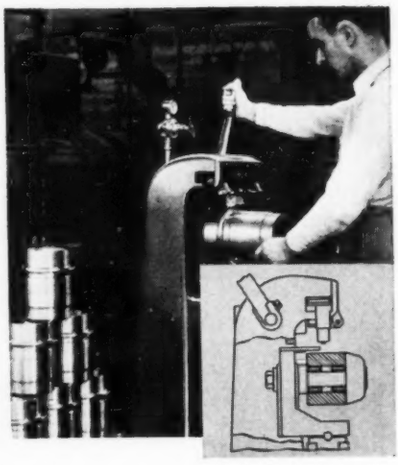




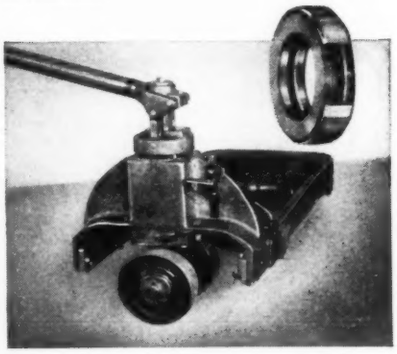
MACHINING GIANT CASTINGS to precision limits is simplified by this 6-inch spindle, floor-type horizontal boring, drilling and milling machine manufactured by The Ohio Machine Tool Company. 44 Type LN Needle Rollers, which are used as the pilot bearing of the transmission, as shown in the accompanying cross-section, contribute materially to the smooth, stable and precise performance of these finely engineered milling machines. Needle Bearings in all types and sizes from one-quarter inch to over seven inches in diameter for virtually all needs are available from Torrington. Our engineers will be glad to help in the selection of the type to meet your requirements.



WATER FLOWING AT HALF-TON PRESSURES through an 8-inch pipe is controlled by this three element feed water control valve made by the Bailey Meter Company. The valve is part of the control system of a modern high pressure boiler which serves a 60,000 kwh turbine in an electric generating plant. As shown in the accompanying cross-section, Type NCS Needle Bearings assure dependability and ease of operation for which this valve is noted. Further information on Needle Bearings is available on request.



MARKING ROUND OR FLAT SURFACES, precision graduating and serial numbering are the accomplishments of this versatile Pneumatic General Purpose Marking Machine built by the Noble and Westbrook Manufacturing Company. The worker shown here is marking part numbers on finished aircraft engine cylinder barrels, while the cross-section shows the mandrel support which holds the work. A compact, high capacity Type NCS Needle Bearing carries the mandrel to provide ease of rotation.



MATERIALS HANDLING with manual equipment is aided by such modern items as this liftruck manufactured by the Revolvator Company. Unusual maneuverability is made possible by the free 360° swing of pump and pulling handle, which is designed for anti-friction operation through use of a Torrington Ball Thrust Bearing in combination with a Type DC Needle Bearing.

IF YOUR NEED IS FOR LARGE BEARINGS, Torrington-Bantam's experience in the design, application and manufacture of outsize bearings is of special value. Or if you have a bearing problem which appears to call for special treatment, the experience of Torrington engineers in the design and application of every major type of anti-friction bearing suggests that you can profitably TURN TO TORRINGTON for expert counsel.

ARMY NAVY

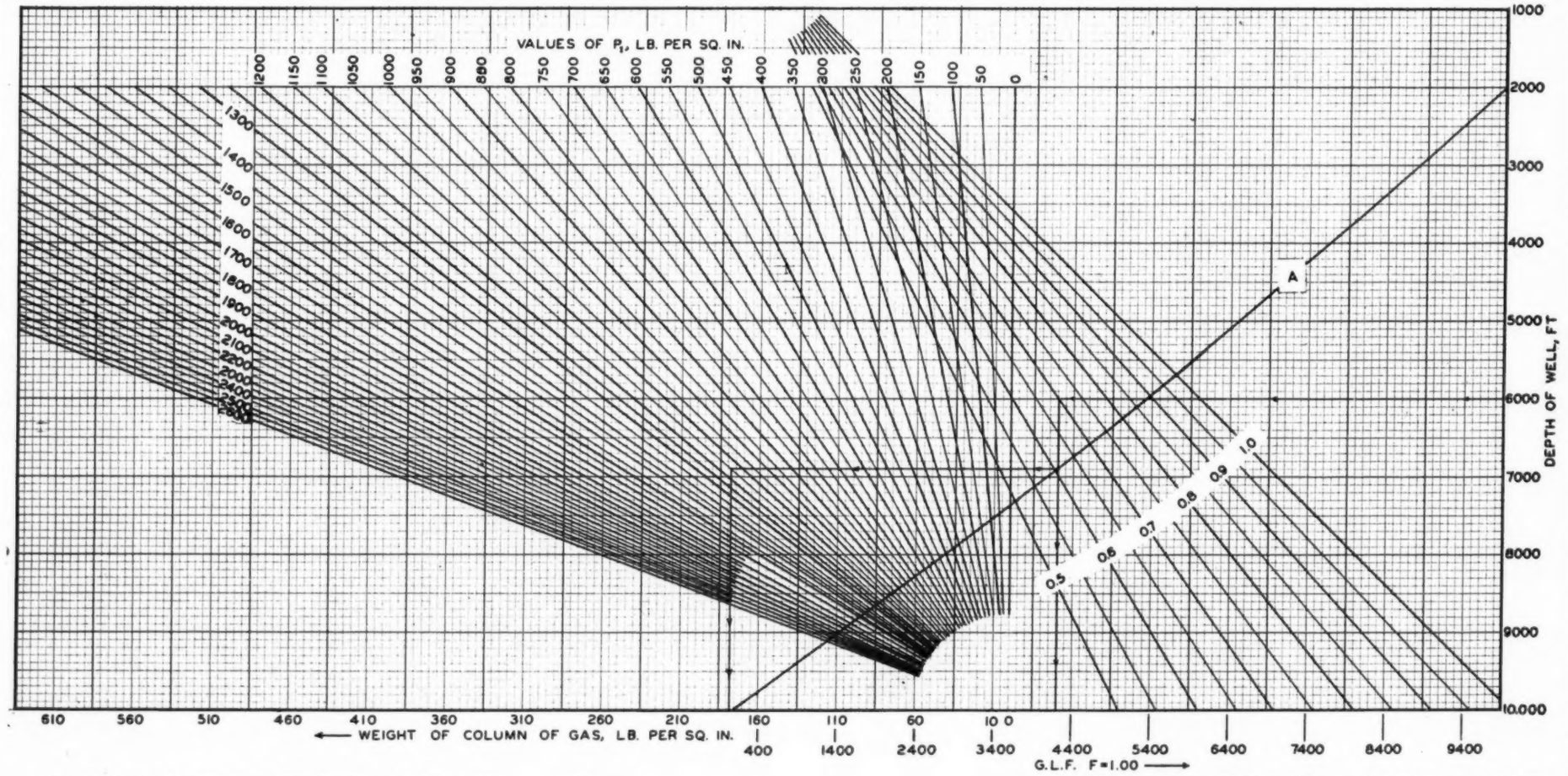
TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

CHART FOR APPROXIMATING BOTTOM-HOLE PRESSURE FROM WELLHEAD PRESSURE



This chart is for the purpose of approximating the bottom-hole pressure of a flowing gas well. When the casing pressure of a gas well is known, the bottom-hole pressure may be found by adding the weight of the column of gas. E. L. Rawlins and M. A. Schellhardt, senior petroleum engineer, and associate natural-gas engineer, respectively, of the U. S. Bureau of Mines gives the following formula for the weight of a moving column of gas.

$$P_s - P_1 = P_1(e^{0.0000347GLF} - 1)$$

Where:

F = a correction factor which takes into account the decreased density under flow conditions as compared with static conditions.

Pressure due to the weight of static column of gas without considering the deviation of gas from Boyle's law is:

$$P_s - P_1 = P_1(e^{0.0000347GL} - 1)$$

Where:

P_s = pressure at bottom of hole, lb. per sq. in. abs.

P_s = pressure at bottom of hole, lb. per sq. in. abs.,

$P_s - P_1$ = pressure due to weight of static gas column, lb. per sq. in.,

G = specific gravity of gas (air = 1.00),

L = average length of gas column, ft., and

e = Naperian logarithm base = 2.71828.

In order to facilitate a ready and rapid means of ascertaining the gas weight values used in gas and gas-lift engineering, the above chart has been prepared which takes into account the values used in making these calculations. A typical example in the use of the chart is shown by arrows on the chart, as follows: The length of the gas column (depth of well in feet) on chart = 6000 ft. Move horizontally from this point on the chart to the specific gravity of the gas, which in this case is 0.70; then vertical to A (F values), correction factor moving column of gas. From this point on the chart to the casing pressure value, which in this case is 1150 lb. Then vertical to the values shown, weight of column of gas, lb. per sq. in. which is about 180 lb. per sq. in. Therefore, the pressure at the sand or bottom hole pressure is 1150 + 180 + 15 = 1345 lb. per sq. in. abs. (under such conditions as outlined on chart).

For example in the use of the chart in determining the bottom-hole pressure of an oil well, using gas lift as a medium of assisting flow (open system without a packer) and the injection level of the gas from the casing into the tubing is known:

Well depth = 7000 ft.
Injection level (or flow collar level) = 6000 ft.
Gradient of fluid = 0.4 lb. per sq. in.
Casing pressure or injection pressure at casing = 1150 lb.
Weight of the column of gas = 1150 + 180 + 15 = 1345 lb. per sq. in.
Fluid column in casing = 7000 — 6000 = 1000 ft.
Therefore:
1000 × 0.4 = 400 lb. per sq in.
Estimated flowing bottom hole pressure = 1345 + 400 = 1745 lb. per sq. in. abs.

—Chart by Warren J. Jackson.

HAZARD LAY·SET *Preformed* REWARDS YOU BY—

One of these invariably justifies its specification

1. LASTING LONGER
2. BEING SAFER TO HANDLE
3. SPOOLING BETTER
4. BEING FASTER TO INSTALL
5. **REFUSING TO "PORCUPINE"**
6. MAKING LANG-LAY MORE SERVICEABLE
7. BEING FREE OF TENDENCIES TO KINK
8. REQUIRING NO SEIZING WHEN CUT
9. RESISTING BENDING FATIGUE LONGER
10. GIVING YOU GREATER DOLLAR VALUE

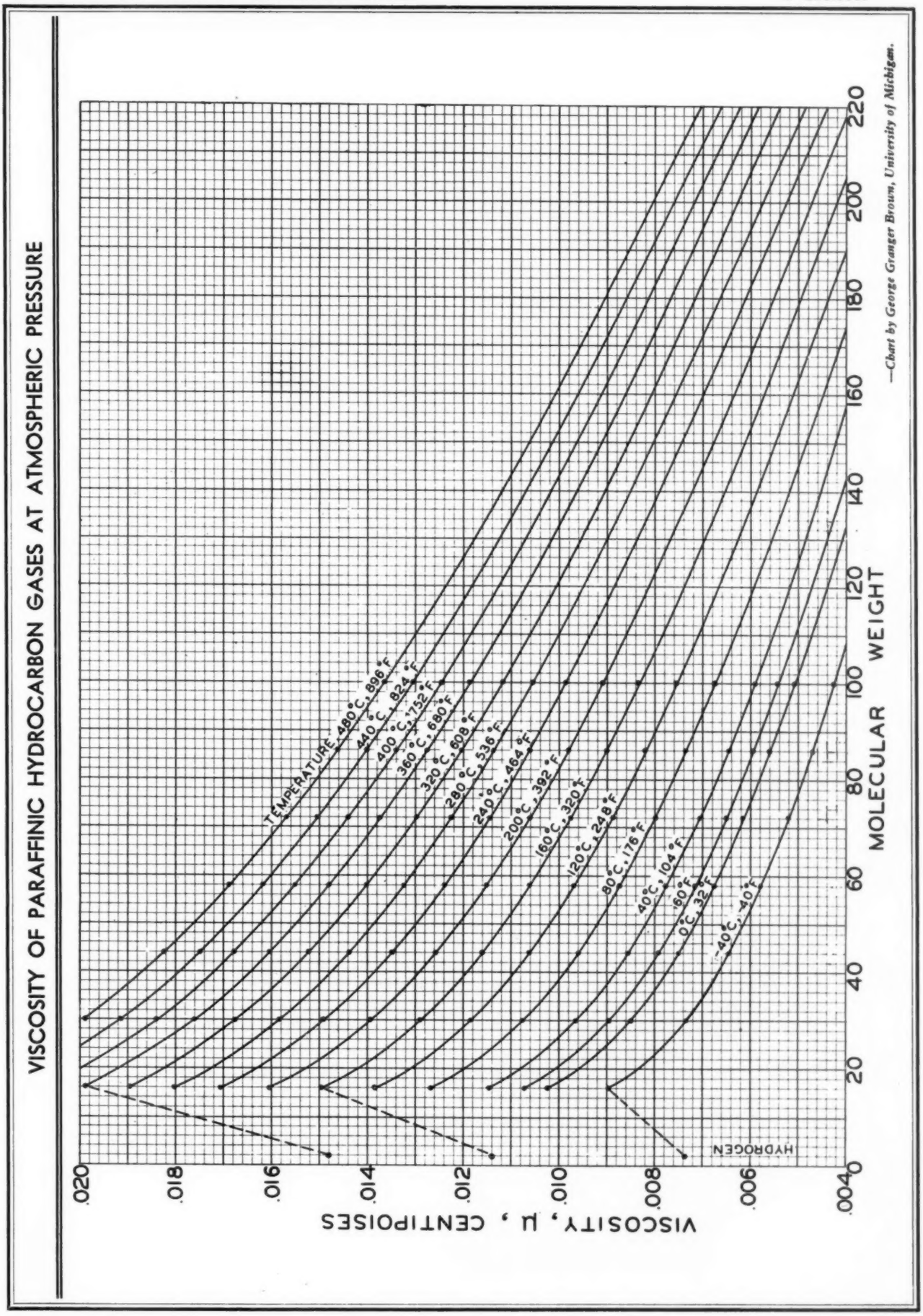
Look closely at this discarded Hazard **LAY-SET** Preformed wire rope. See any protruding wires?... No—not one of those broken crown wires leaves its assigned place. They remain flat and in place *because they are preformed.* • This means safer, faster, surer handling by workmen. No vicious barbs that may cause blood-poisoning and compensation claims. Hazard **LAY-SET** Preformed instills confidence in your men; fewer time-out accidents; steadier production. • It also means longer rope service and fewer needless damages to your equipment. Specify Hazard **LAY-SET** Preformed for your next rope. It gives you greater dollar value.

HAZARD WIRE ROPE DIVISION • Wilkes-Barre, Pa., Chicago, Pittsburgh, Fort Worth, Houston, Wichita, San Francisco, Denver, Los Angeles

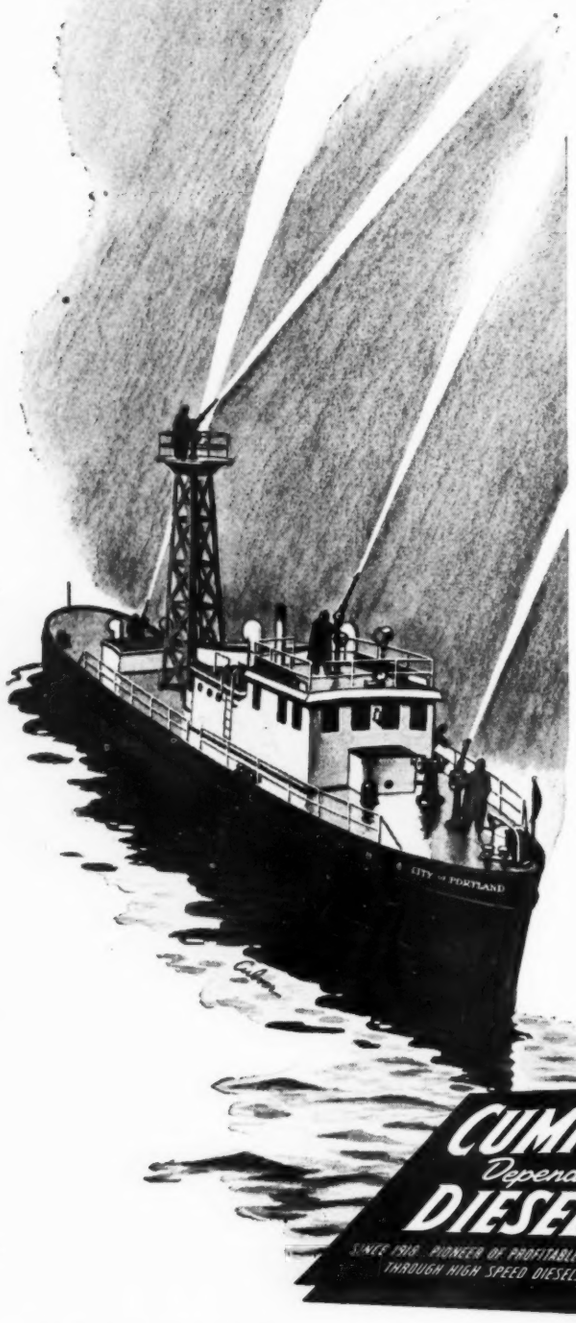
Distributors in all important oil field centers

AMERICAN CHAIN & CABLE COMPANY, INC. • BRIDGEPORT, CONNECTICUT

HAZARD LAY·SET *Preformed* ROTARY LINES


VISCOSITY OF PARAFFINIC HYDROCARBON GASES AT ATMOSPHERIC PRESSURE
—Chart by George Granger Brown, University of Michigan.
TEMPERATURE
480°C, 896°F
440°C, 824°F
400°C, 752°F
360°C, 680°F
320°C, 608°F
280°C, 536°F
240°C, 464°F
200°C, 392°F
160°C, 320°F
120°C, 248°F
80°C, 176°F
40°C, 104°F
16°C, 60°F
0°C, 32°F
-40°C, -40°F
HYDROGEN
VISCOSITY, μ, CENTIPOISES
.020
.018
.016
.014
.012
.010
.008
.006
.004
MOLECULAR WEIGHT
20
40
60
80
100
120
140
160
180
200
220

This *Fuel Conservation* started 15 years ago!



The principle of Fuel Conservation is to eliminate waste without sacrificing any vital need. For example:

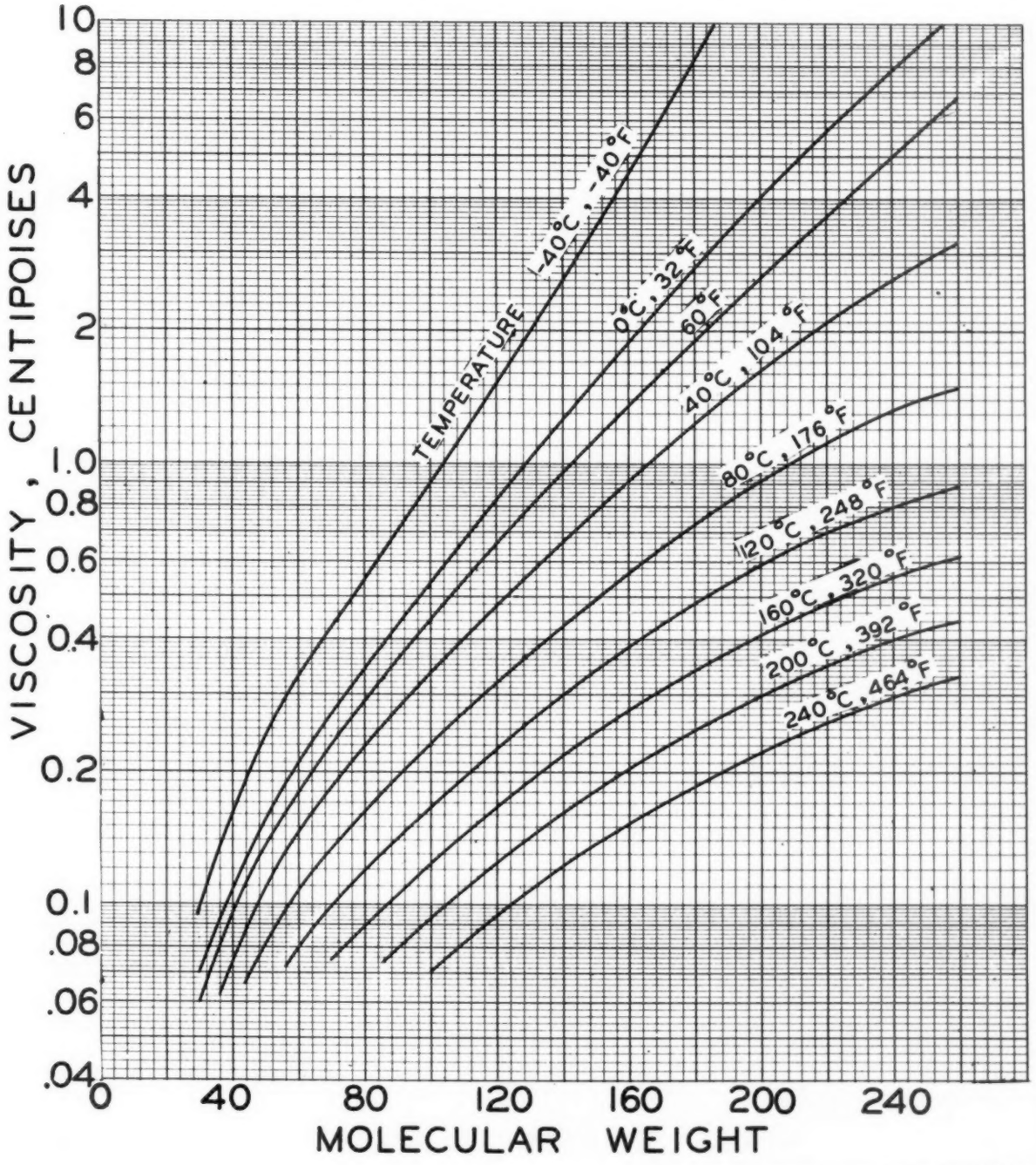
In 1928, fire protection for its harbor was a vital need at Portland, Maine, but natural New England thrift rebelled against paying for fuel which would be consumed in idleness . . . in merely keeping up steam to assure having fire protection when it was demanded. After a thorough investigation, the fire boat, City of Portland, was ordered and Cummins Diesel power was chosen for three reasons: *First*, the Cummins Diesel's proved easy starting made certain that the boat would be ready to go any time, day or night. *Second*, the engine's compact size and light weight per horsepower made it an ideal plant for fire pumps and main propulsion. *Third*, the Cummins Diesel's recognized fuel economy and low maintenance assured a low operating cost.

In 15 years of duty on Portland's water front, and in comparable terms of service in fire boats at Chicago and Ketchikan, Alaska, Cummins Diesels have consistently demonstrated their ability to provide maximum protection at a minimum cost in dollars, manpower and fuel.

Such economy—multiplied by the many thousands of Cummins Diesels doing scores of jobs essential to a nation at war—becomes doubly valuable now when every dollar and every man and every drop of fuel is so vitally needed to push the fight on the battle front and the home front. CUMMINS ENGINE COMPANY, Columbus, Indiana.

Distributors Mid-Continent Territory: **MID-CONTINENT SUPPLY COMPANY, Fort Worth, Texas**

VISCOSITY OF PARAFFINIC HYDROCARBON LIQUIDS AT ATMOSPHERIC PRESSURE



—Chart by George Granger Brown, University of Michigan.

BROWN FINTUBE'S

New...

Improved

Standard sizes
from 6 to 22 feet overall.

SECTIONAL HEAT EXCHANGERS

give users many advantages never before available

● Featured in these new exchangers is a "non-removable" rear end assembly. You simply remove the bolts, back the cover plate off far enough to clear the adjacent "sections," then swing the plate through a 180° arc, to gain clear, unobstructed entrance into the exchanger. There are no heavy members to take off, lower to the ground, then raise back up and put back on again. Consequently inspection, or the substitution of one "hairpin" for another so as to use the same "stand" for different duties, is easy, quick and inexpensive.

The new "head" seal employing a solid ring and two split collars tightened with cap screws, is assembled easily with only an 8″ crescent wrench. This construction avoids outboard stress on the split ring lock,—and tests with a solid copper gasket have proved it capable of holding more than 2000 pounds pressure for days, without trace of any "weeping."

In addition, these exchangers have welded one-piece "hairpins" that positively prevent any mixing of the tube-side and shell-side commodities,—and, through the use of Brown Fintubes, provide the high thermal efficiency and trouble-free operation only Brown resistance-welded integrally-bonded fintubes can give you.

Brown integrally-bonded Fintubes are used in all Brown Fintube Heat Exchangers,—are available in exchangers made by most other manufacturers,—and are ideally suited for many other heating and cooling services. Furnished in plain "longitudinal" or "cut and twisted" types,—wide range of sizes, in low carbon or special steels. Design assistance furnished gladly.

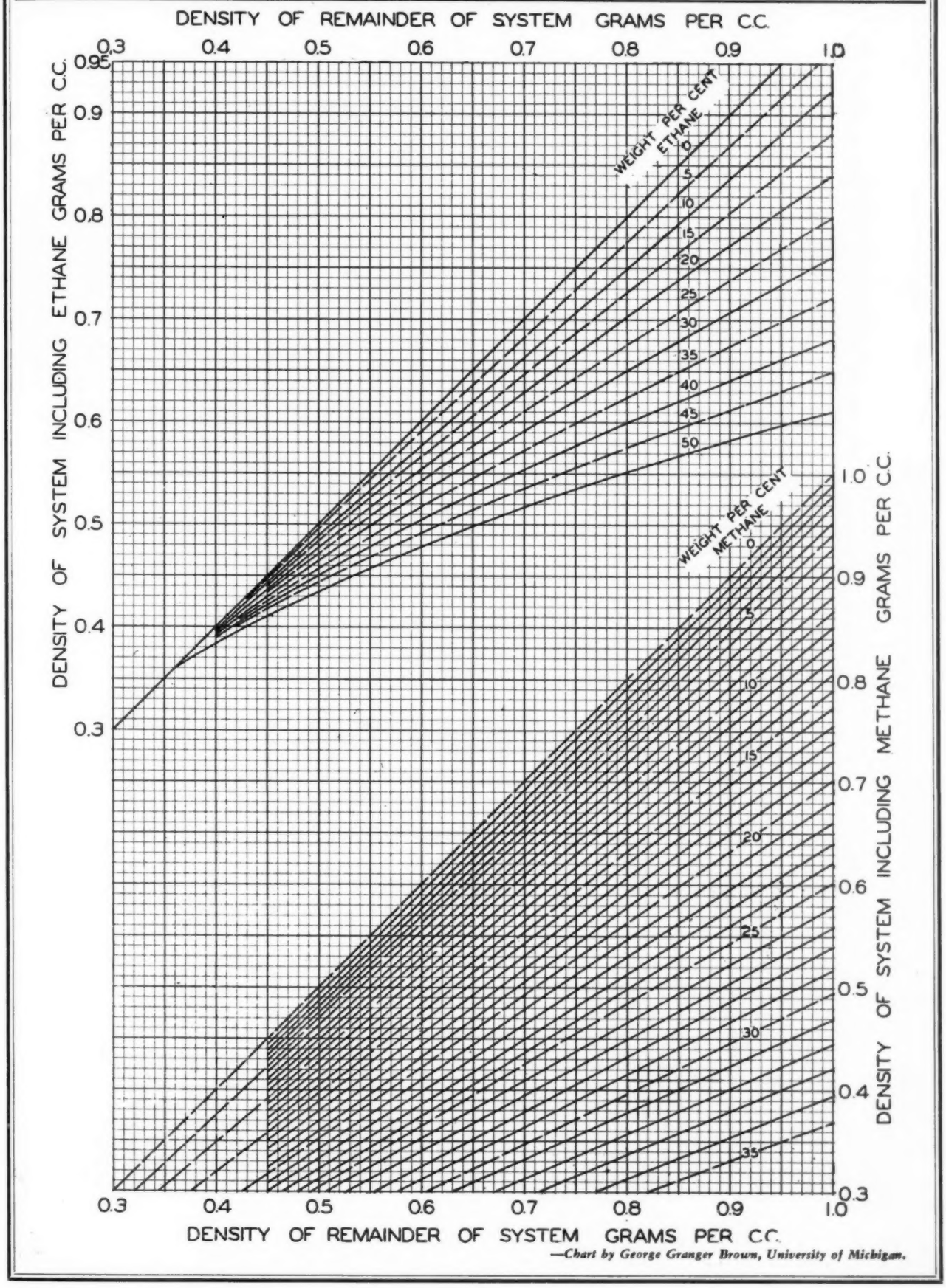
A fully descriptive engineering bulletin, complete with dimensions and other data of interest to every engineer and operating men sent gladly on request. No obligation. Send for Brown "Sectional Hairpin" bulletin today.

THE BROWN FINTUBE CO.

125 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

DENSITY OF METHANE AND ETHANE SYSTEMS



—*Chart by George Granger Brown, University of Michigan.*

"I'LL TAKE

WHITNEY CHAINS

FOR DURATION DRIVES

on everything I'm responsible for!"

Oil field engineers bank on Whitney Roller and Silent Chains to keep their equipment operating 24 hours a day ... *every day* ... and to pack every hour with top production, maintained by a full and even flow of power. For responsibility is built deep into every pin, link, and bushing of every Whitney Chain ... starting with the metallurgical control of Whitney *alloy-armored* steels and continuing through every step of manufacture and assembly. On all *your* equipment, too, you can bank on Whitney Chains to stand up and not let you down. And you can bank on Continental to give you prompt service and any engineering assistance you need. Get drive troubles off your mind once and for all ... Call Continental for Whitney Chains.

The WHITNEY CHAIN & MFG. CO., Hartford 2, Connecticut

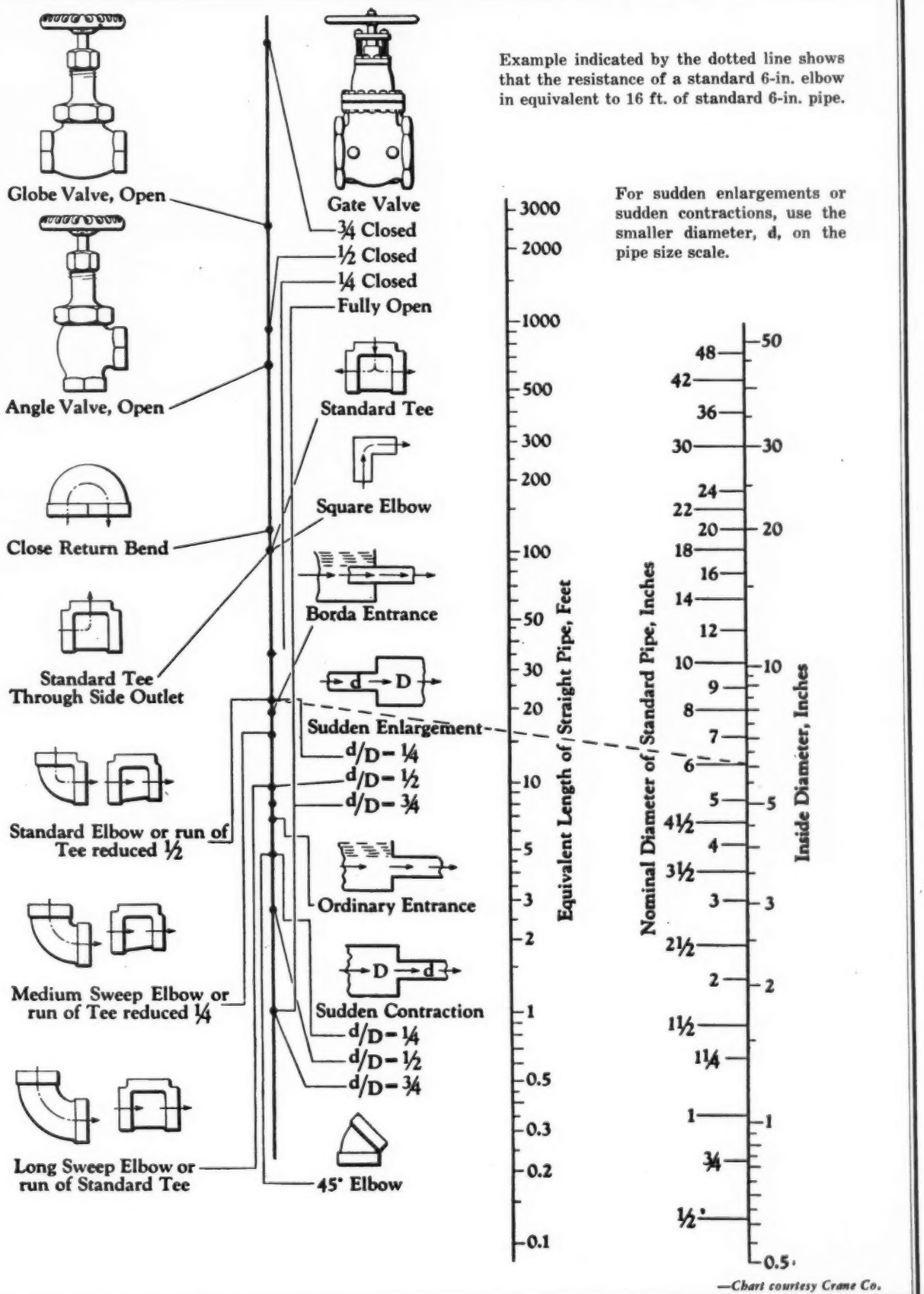
WHITNEY CHAINS

DISTRIBUTED BY

THE CONTINENTAL SUPPLY CO.

DALLAS, TEXAS

VALVE AND FITTING RESISTANCE TO FLUID FLOW



—Chart courtesy Crane Co.

When Installing Bearings

IT PAYS TO BE A "YES-MAN"

These hints will help you get maximum performance from all types and makes of bearings. They are highlights from Hyatt's Bearing Maintenance Handbook, and are published here as a wartime service.

Yes

Keep bearings clean... away from dust, dirt and moisture. Leave them in original wrappings until ready for use. (Hyatt Roller Bearings are protected against rust and corrosion by a special lubricant)

No

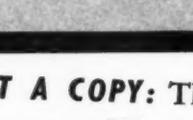
Do not handle bearings unnecessarily; avoid touching roller operating surfaces, as moisture from the hands may cause rust. Be sure that hands, tools and surroundings are clean at all times.

Yes

When bearings or bearing parts are assembled on a shaft, apply pressure to end of inner ring or race; when in a housing, apply pressure to end of outer race. Lubricate all shaft and housing surfaces which are in contact.

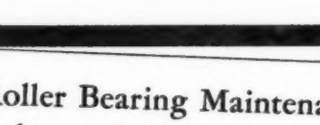
No

Never apply pressure to roller cages, ball retainers, seals or end rings. Don't "cock" the race ... damage to both shaft and bearing will result. Always apply pressure to the race ends straight and square.



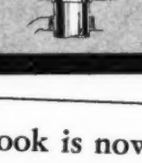
Yes

Assemble bearing on shaft and into housing carefully to avoid scoring races and rollers. Lubricate thoroughly and regularly according to manufacturers' specifications, using fresh, clean lubricant.



No

Never, never, NEVER strike any part of any bearing with a hammer. Use an arbor press, hammer-and-drift, or bearing driver instead. Avoid using wooden or soft metal mallet, as chips may get into the bearings.



GET A COPY: The Hyatt Roller Bearing Maintenance Handbook is now off the press. Would a copy help you? If so, write on company letterhead to Department 204, Hyatt, Harrison, New Jersey. We'll be glad to send you a copy with our compliments.

HYATT ROLLER BEARINGS

HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION · HARRISON, N. J.

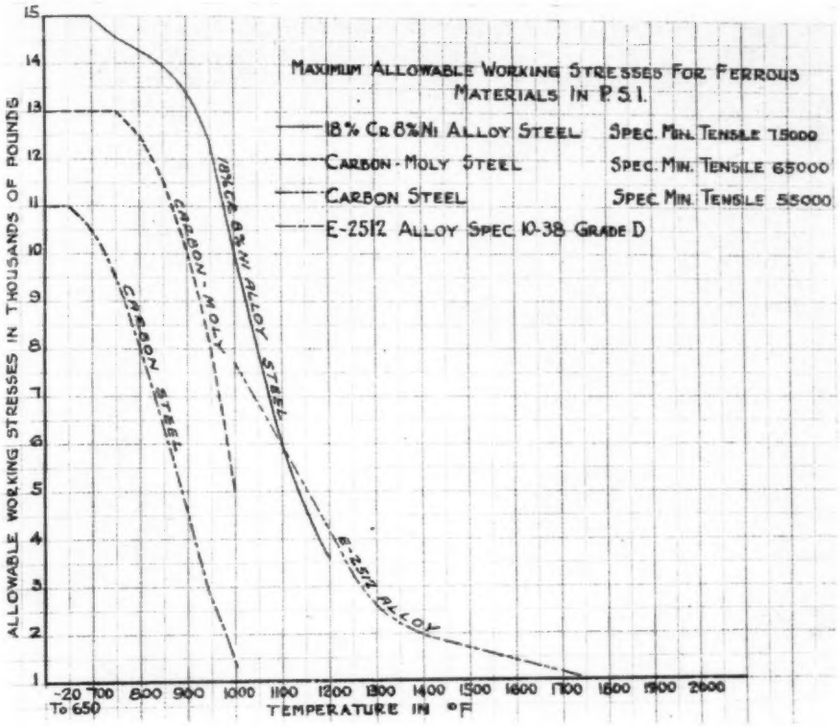


Fig. 1. Curves showing maximum allowable working stresses for ferrous materials

by

William H. Hill

President, Baldwin-Hill Company

Internal Insulation for Pipes Under High Pressure

☆ **Piping of ordinary weight and construction handles high temperatures successfully**

A VAST program of synthetic rubber, 100-octane gasoline, and munition plant construction was initiated after Pearl Harbor. Many of the processes involved petroleum gases, superheated steam, and mixed vapors at temperatures ranging from 1000 to 1500°F., which were conducted through pipes under considerable pressure—some of the pipes being as large as 8 ft. in diameter and several hundred feet in length. The vast amount of alloy steel necessary to handle these vapors in the conventional manner presented a problem—alloy steel was high on the critical list. Pre-war sources of vital alloys either had fallen into enemy hands or were seriously restricted by shipping problems. Demand for these materials for aircraft, ordnance, and similar production was tremendous. It was definitely a limiting factor in the production of much-needed war material.

Faced with the high cost and sharply limited availability of alloy and inherent design difficulties in large high temperature piping, a large engineering construction company had begun in 1939 development of internally insulated piping, and had made an initial installation in 1940. From the experience gained in this and subsequent installations, officials were confident that carbon steel pipe of ordinary weight and construction could handle successfully the high temperatures involved in the new processes if a layer of insulation was placed inside the pipe.

Insidline, the resulting internal insulation for pressure piping developed by Baldwin-Hill Company, Trenton, New Jersey, accomplishes this—not by the use of new materials, but rather by new combinations and arrangements of existing materials that make it possible to handle these high temperature gases and vapors, under pressure, through piping of comparatively light weight and low cost. This important development made it possible to carry on the construction of synthetic rubber and high octane gasoline plants without drawing on the supply of critical alloys—thus enabling their use where alternates were neither available nor practical.

Construction

Insidline construction consists of a layer of high temperature insulating material placed against the inner surface of the pressure piping. The insulating material is a felted block with a diatomaceous earth base reinforced with amosite asbestos fibers. It is retained and protected by metal liners arranged in a manner to provide adequate expansion clearances with minimum heat flow through the metal. The inner liner is not required to resist pressure and is therefore not made pressure tight. It is only slightly stressed by its own weight, the impact of high velocity gases, and the negligible weight of insulating material. Its composition and thickness can be varied to meet conditions of

temperature, corrosion, erosion, and velocity encountered in various installations.

The primary objective of the internal insulation and lining is to hold the temperature of the pressure piping to 650°F. or below, where the phenomenon of "creep" does not occur and metals can be operated indefinitely at the usual stress allowance. (See Fig. 1.) Thus, the use of carbon steel piping normally specified for a given pressure is made possible for a wide range of internal temperatures.

The secondary objective of the insulation is heat conservation, and this can be carried to any degree indicated by the economics or other considerations in a given process. The relative thickness of internal and external insulations are determined by the desired pipe wall temperature and rate of heat transmission. In practice, the internal thicknesses have varied from 1 in. to 4 in. and the external thicknesses from zero to 2 in.

The use of the insulation simplifies the design of pressure piping with considerable reduction in the number of expansion joints, bends, and other provisions for pipe expansion. Resulting weights are reduced with saving in supports and other structural details.

Installation

Two general classes of construction are used, dictated by the size of piping. Above 36 in. diameter, the entire construction is assembled within the pipe in the following order: Reinforcing rings and slip joint, insulating block, segmental liner (panels), through metal anchor buttons, and cover plates. The flexibility of modern arc welding is used to accomplish all assembly connections. Good welding technique results in smooth surfaces to minimize pressure drop and erosion.

Under 36 in. a cylinder or cartridge is rolled, welded, and suitably reinforced. The insulation is applied to required thickness and retained by a thin carbon steel sheet that acts as a jacket to protect the insulation during installation. The complete cartridge is then inserted into the pipe and anchored by a cone connecting the inner liner to the pressure piping by welding. The next cartridge is then positioned to allow for expansion and is similarly anchored.

At elbows the insulation is a loose fill type and is tamped into place after the section of inner liner has been positioned.

In pipes too small to allow a man to work inside, the cartridges are joined and pulled into the pipe. Shop fabrication is normally employed, with the pipe shipped to the field ready for erection. With welded connections, a portion of the insulation and liner at the weld is installed after erection.

Cartridge type insulation installed

Expansion joints require special treatment, but can be adequately protected against high temperatures and heat loss. The entire method of construction is flexible and enables special fittings and shapes to be handled without difficulty.

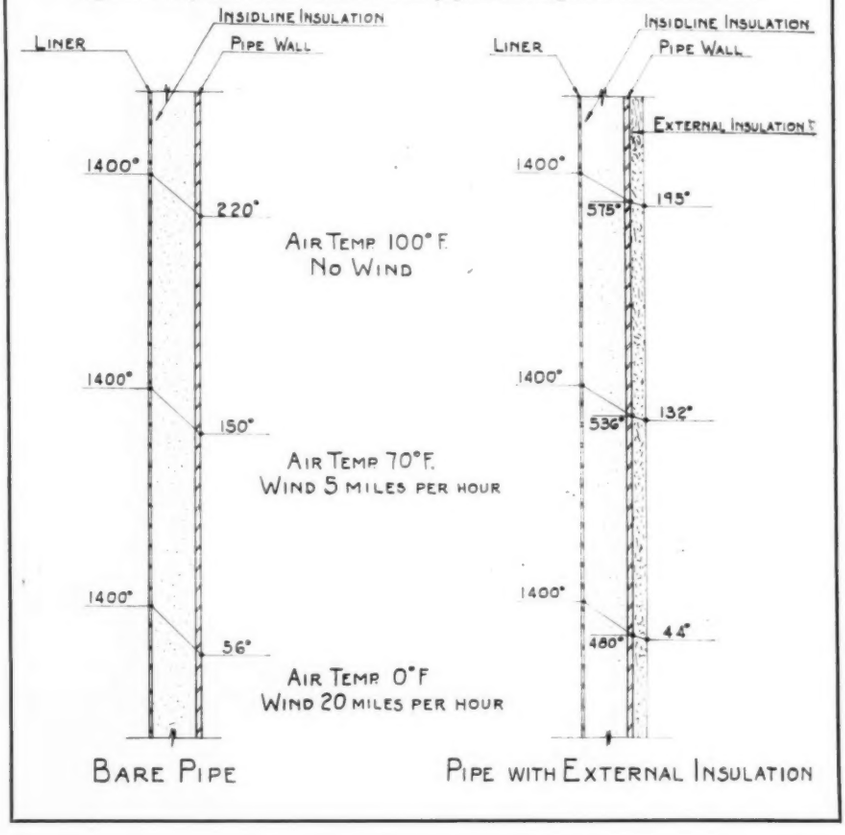
Applications have been made for flue gases, steam, petroleum gases, hydrogen and fluid catalysts for pressures up to 300 lb. and temperatures up to 1500°F. in various combinations. These conditions have necessitated installation in pipe sized from 2 in. up to 100 in. in diameter and ranging from a length of a few inches up to single lengths of 60 ft. on the straight. Velocities up to 500 ft. per sec. have been used.

Use of the insulation has permitted the development of processes involving extremely high temperature and large sizes of pipe and equipment (see Fig. 2) without resorting to the use of excessive quantities of alloy steel, which would not have been available or the use of which would have retarded other important government war programs.

To date it is in the petroleum refining field that most of the combinations of high temperatures, pressure, and volume of fluids in the vapor phase to be conducted through pipes are found. A steady increase in temperatures is anticipated in this field as well as others, and the application of the insulation will considerably lower the cost of piping required, even when alloy is again readily available. As the temperature rises beyond 1200°F. this advantage increases rapidly, and when a certain temperature range is reached, the alloy may be unacceptable from a long term safety standpoint, no matter how lightly stressed.

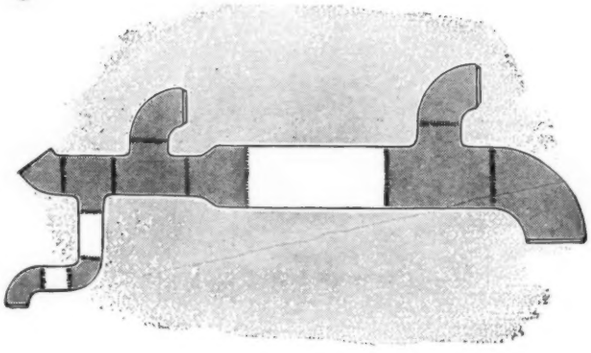
☆ ☆ ☆

Fig. 2. Temperature distribution in pipes having internal insulation



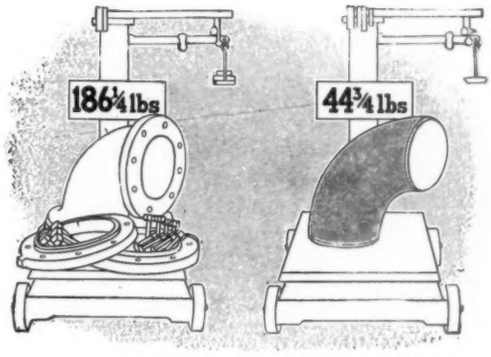
NO. 10 OF A SERIES
HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY
The FIRST SEAMLESS WELDING FITTINGS 1ST

Improve industrial piping 4 ways with Tube-Turn welding fittings!



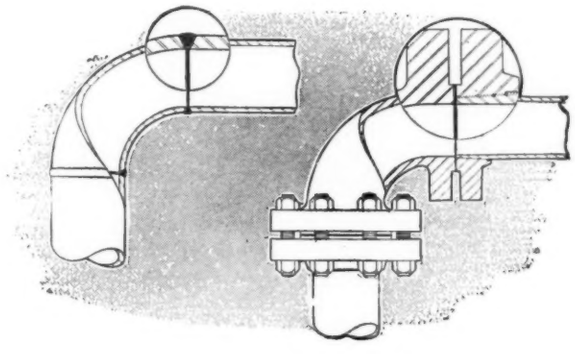
1. Easily preassembled—speed installation

Save from 50% to 75% time by pre-assembling difficult piping sections like this in the shop. Tube-Turn fittings are ready to use. They simplify lining-up, require only easy, circumferential butt welds. This insures faster, better and safer welding by either veteran or novice welders—a real war production help.



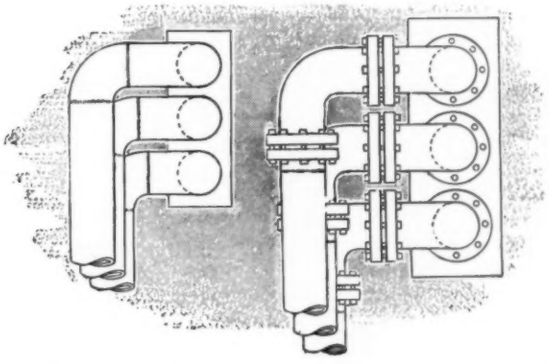
2. Reduce weight—conserve materials

Look at the weight saved by using an 8" Tube-Turn elbow instead of a heavy 8" cast iron flanged ell with companion flanges, studs and nuts. Multiply this saving by the many fittings in any piping system and it's easy to see how Tube-Turn fittings save tons of weight, metal and critical materials.



3. Avoid "down time"—reduce maintenance

Note how the welded connection virtually forms a continuous tube without joints—insures permanently leakproof, trouble-free connections that last as long as the pipe itself! Such maintenance headaches as leaks, gasket changes, bolt tightening, caulking, threading, and difficult insulatings are totally eliminated



4. Streamline systems—save space

Contrast the space saved in these compound turns by using Tube-Turn elbows instead of flanges. Tube-Turn fittings require less space, permit streamlined, compact layouts and neater, more efficient piping. Elbows can be cut to any odd angle. Saving space is important in most industries, is vital in shipbuilding!

TUBE TURNS (INC.) Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle. *Distributors in principal cities.*

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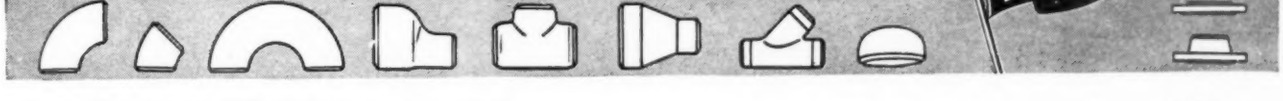

Buy another War Bond this week!

Wyoming Refinery for Production Of Aviation Gasoline

☆ Processes being added to Frontier plant will make 100-octane fuel from Rocky Mountain crude oil

THE Frontier Refining Company of Wyoming will soon put into operation new facilities for the production of 100-octane fighting grade aviation gasoline—just how much is a military secret. These new facilities are the result of the determination of M. H. Robineau, president of the company, to participate in the war effort in the most effective way and to bring to Wyoming, one of the important oil-producing states, a fair share of the manufacturing of this vital war material.

A little more than a year ago the Frontier Refining Company had a crude oil capacity of 1600 bbl. a day, and a Dubbs cracking unit with a rated capacity of 750 bbl. a day. Immediately after Pearl Harbor Robineau, in cooperation with the Universal Oil Products Company, worked out plans, which were subsequently approved by the Petroleum Administration for War, for the installation of processes to convert effectively products from Rocky Mountain crude oil into 100-octane aviation gasoline. These new facilities, which will more than double the crude oil capacity of the existing refinery, include the following Universal Oil Products Company units: Fluid-flow catalytic cracking, hydrogen fluoride alkylation, butane isomerization, and thermal reforming. These were all designed and licensed by Universal. The new equipment also includes a gas concentration unit.

The new facilities are financed and owned by the Defense Plant Corporation. The contract for construction was let to the Fluor Corporation of Los Angeles on May 12, 1942, and construction is proceeding as fast as materials are available.

In order to appreciate the importance of the Frontier refinery, consider the product it is to make—100-octane aviation gasoline. The success of the United Nations' flyers in winning superiority over the enemy would have been impossible without the plentiful supplies of this supertuel made available to them by the American oil industry.

The achievement of the oil industry in producing this fuel of victory has been called a "near miracle," and efforts are being increased throughout the industry to produce still more to fill the rising demands.

Making 100-Octane Gasoline

One-hundred-octane gasoline is not, like most motor gasoline, produced by a relatively simple operation. It is a mixture of selected hydrocarbons that must be made by special processes, requiring expensive, complicated equipment and large quantities of critical materials.

The basic constituents of 100-octane aviation gasoline are *iso*pentane, alkylate, and high-octane base stock.

*Iso*pentane, a C_5 hydrocarbon having a high octane rating and satisfactory lead susceptibility, is used to meet the vapor pressure and volatility requirements.

Alkylate, a saturated hydrocarbon consisting largely of trimethyl pentanes, might be called the backbone of aviation gasoline, because, when leaded and blended with the other components, it gives excellent performance in the various phases of flying, such as cruising, take-off, and combat.

The base stock might be called the filler, and usually is a full boiling range aviation fraction having an endpoint of about 325°F. In order that the maximum value of the alkylate may be realized, the base stock should have a high octane number and, preferably, a high enough aromatic content to give good performance under full throttle conditions.

In the Frontier plant a combination of thermal and catalytic processes is carefully balanced to produce all these vital constituents of aviation gasoline in optimum proportions for use in the finished blended product. The heart of the operation is the catalytic cracking unit. This produces *iso*pentane, which is a high octane base stock for aviation gasoline, and a considerable quantity of *iso*butane and olefins, which are raw materials for the production of alkylate. Additional olefins and butanes for alkylation are produced in the Dubbs thermal cracking and thermal reforming units. Alkylate is produced in the alkylation unit by combining olefins and *iso*butane, with hydrogen fluoride as the catalyst.

In order to supplement the *iso*butane available from these operations and to make full use of the olefins to produce the maximum yield of alkylate, the butane isomerization unit converts available normal butane into *iso*butane.

The new facilities also include provision for processing raw materials from nearby refineries. Transportation of these raw materials will be by tank truck in order to leave tank cars free for other necessary long-haul service.

Robineau has behind him a long record of experience in the oil business, which he entered on the marketing side. Born in Syracuse, New York, he paid his way through the Colorado School of Mines by conducting his own orchestra in Denver hotels. He was graduated in 1923 with the degrees of mechanical engineer and mining engineer. On leaving school, Robineau went to work for The Texas Company as district manager in western Nebraska, with headquarters at Sidney. In 1925 he entered the jobbing business for himself and soon had flourishing stations throughout Nebraska.

His step into the refining end was taken in 1936 when he leased a skimming plant at Cheyenne, Wyoming. Later, he became connected with the Bay Petroleum Company and took complete charge of building that company's refinery in Denver. He was president of the Bay company when he resigned in 1938 to establish the Frontier Refining Company.

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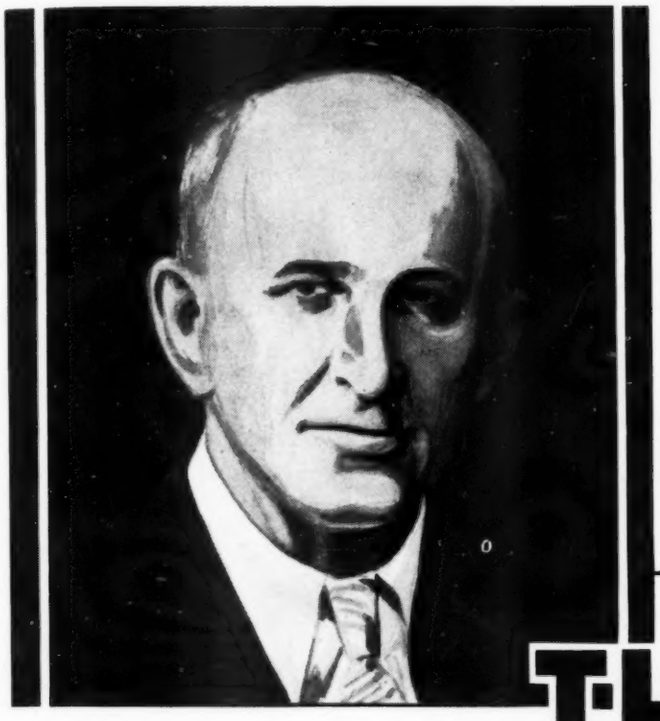

THIS MAN

IS A FRIEND OF YOURS

He's a typical Jarecki store manager — friendly, competent, co-operative.

He makes it his business to study the needs of the territory he serves — and patterns his stock accordingly.

Behind him is a tradition of service stretching back to 1852, when the first store was established. Cooperating with him in meeting the needs of oil men is a chain of stores strategically located throughout the oil country, and operated by equally competent men.

The Jarecki store manager is a pleasant fellow to know, and a good man to get in touch with when in need of supplies.

JARECKI
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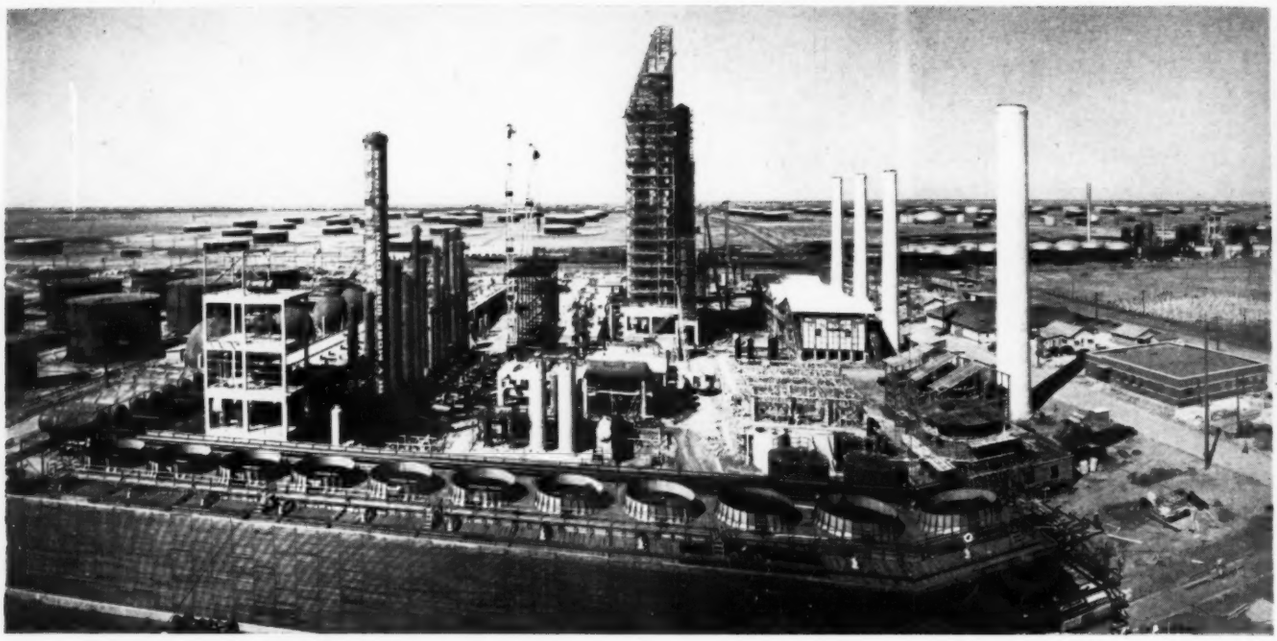
"Since 1852"

General Offices: St. Louis, Mo. Home Office and Factory: Erie, Pa., U. S. A. District Offices: Tulsa and Bartlesville, Okla.; Dallas and Houston, Texas; Mt. Pleasant, Mich.; Centralia, Ill.; Owensboro, Ky.
Branch Stores at All Important Places in the Oil Country



Continental Oil Company's 100-octane aviation gasoline plant being built at Ponca City, Oklahoma

Continental's 100-Octane Gasoline Plant

☆ Thermofor catalytic cracking and alkylation units being installed

CONTINENTAL Oil Company's plant at Ponca City, Oklahoma, for the manufacture of 100 octane gasoline, which is designed to produce approximately 5000 bbl. daily of high test aviation gasoline exclusively for the war effort, has been scheduled for completion by January 1, 1944. Cost of the project will approximate $12,000,000.

The plant includes a thermofor catalytic cracking unit for the production of a base gasoline, and an alkylation plant to produce *iso*octane. These two products will then be blended with tetraethyl lead and *iso*pentane, a product of casinghead gasoline plants, to produce the high test aviation gasoline.

Central unit is the TCC plant, which towers 234 ft. above the surrounding terrain. There are four stacks 125 ft. high, and one stack 150 ft. high. The *iso*pentane tower, which weighs 118 tons, is 11 ft. in diameter and 132 ft. high, and was shipped to Ponca City in one piece on three railroad flat cars. The plant also includes a control laboratory, rail trackage for simultaneous loading of 30 tank cars, storage for 240,000 bbl. of finished products, and a redwood cooling tower for cooling 30,000 gal. of water per min.

Although construction work on the plant began early in August, 1942, no detailed publicity on the project has been permitted under censorship regulations until the release of such information was authorized recently by Robert P. Patterson, under secretary of war.

Approximately 1037 workmen are now engaged in construction work, which is expected to reach its peak about December 1, when approximately 1300 men will be on the job. To help house these workmen a 100-unit trailer village was authorized by the National Housing Authority and completed November 15. The village was erected on a site immediately north of the plant. Eighty of the trailers are family type units and 20 are smaller units that can be annexed to the family units or used separately as quarters for unmarried workmen. The village is laid out in streets, has modern plumbing, sewage disposal, electric lights and city water. Special units also are provided as laundries and shower baths.

When the plant is completed the operating crew will consist of about 200 men.

In disclosing the plant capacity, C. R. Loehrke, superintendent of The Lummus Company, contractor builders of the plant, said it will "make enough aviation gasoline annually for 100 Flying Fortresses to make 681 combat missions of 700 miles each from North Africa to Berlin — carrying enough two-ton, block-busting bombs to blast most of Germany off the map —with maybe a little left over for a few surprise parties in Tokyo!"

The estimate of bomber missions is based on the fact that the plant's capacity of 5000 bbl. daily, working 360 days a year, will have an annual yield of 75,600,000 gal. (42 gal. to the bbl.). A Flying Fortress requires a fill of 1110 gal. for a 700 mile flight.

—— ☆ ☆ ☆ ——

No Steel Plate Fabricating problem is too difficult here, thanks to skilled workmen and modern facilities, backed by 30 years of fabricating experience.
Specify Wyatt's

IT'S STILL A TOUGH JOB BUT

VICTORY WILL COME

All of us must work for those who fight, that all of us may win. It's no time to let down, no time to be complacent. Lives of our boys are at stake. No less than our best is good enough for them.

Materials are scarce, the old must be used to the end of their usefulness. As always, SPANG CABLE TOOLS are giving a full measure of service. After the war they'll be better still, and there will be plenty of them, too.

SPANG & COMPANY • Butler, Pa.

Secondary Recovery

To stimulate interest in secondary recovery methods for obtaining petroleum from oil sands, now important as a war measure, the U. S. Bureau of Mines announces the publication of an engineering report describing 73 water flooding projects in Oklahoma oil fields. The Bureau's report shows that more than 15 million barrels of pertoleum were recovered as a result of the injection of 200 million barrels of water on approximately 350 leases, comprising more than 8000 acres.

Although water was injected into oil sands in Pennsylvania and New York more than 40 years ago, resulting in cumulative additional recovery of more than 200 million barrels of oil, water flooding in Oklahoma did not begin until 1931, according to the report. After considerable experimenting, Oklahoma oil companies undertook water flooding on a wide scale to recover large quantities of the oil, which frequently was left in sands because of declining gas pressures. By July, 1942, the number of water flooding projects on partly depleted reservoirs reached 73, of which 61 still were in operation.

In lieu of specific rules and regulations governing water flooding in the state, the Oklahoma Corporation Commission issues permits upon request of oil well operators. To July 1, 1942, 38 companies and individuals had been granted permission by the commission to water flood 31,392 acres.

"Considering all flooding projects, including those which were complete failures and those which were started only recently, the production of oil to July 1, 1942, by the injection of water into oil sand amounted to 1900 bbl. per acre," said D. B. Taliaferro, petroleum engineer, and David M. Logan, senior production specialist of the Petroleum Administration for War, authors of the report. Material for the Bureau's report, which contains 54 illustrations, was obtained under a cooperative agreement with the State of Oklahoma.

"The Engineer's Song"

Walter M. Ralph, National Aniline and Chemical Company, New York City, offers this new stanza to "The Engineer's Song," of the U. S. Engineers, in which the petroleum engineer is given his place in the sun:

"Who twists the hydrocarbons into
Structures strange and queer,
Who looks at coal tar chemistry
With a most disdainful sneer;
Who revamps his whole technology
A dozen times a year?
It's the polymerizing, catalyzing
Petroleum engineer!"

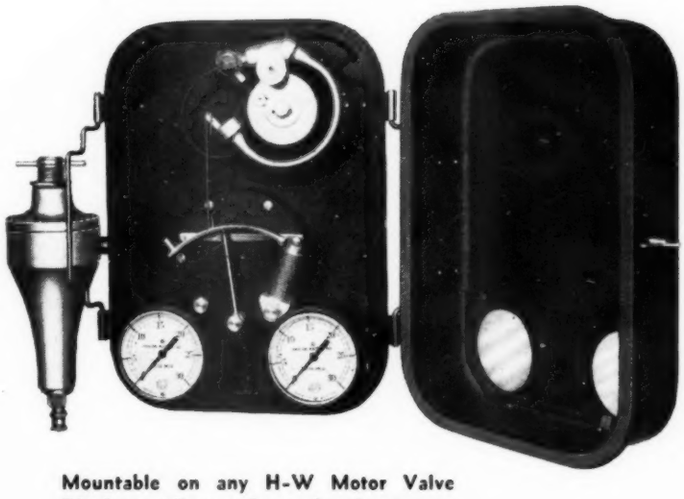
HANLON-WATERS INC.
H-W

Has the *Answer*

FOR EVERY CONTROL PROBLEM

H-W Type 1400 *Pressure Control Pilot*
BOURDON TUBE ACTUATED

Ask the men WHO USE THEM!



Mountable on any H-W Motor Valve Diaphragm Case or for *surface* instrument panel board mounting. Case is weather-proof with wide-swinging door for easy accessibility to instruments for adjustment, repair or replacement of parts. Levers and other working or moving parts are of stainless or plated steel. Bellows of high grade bronze.

H-W Type 1400 Bourdon Tube Actuated Pressure Control Pilot (Non-Recording) is designed to operate as a Vacuum or Pressure Control Pilot for pressures from vacuum to 5,000 lbs. The Type 1400 Pilot has a wide *Throttling Range* adjustment of from 0% to 200%. Thus, this Pilot is universally adaptable for services requiring extremely high sensitivity or for service conditions where wider *Throttling Ranges* are necessary to *dampen* the sensitivity. Wide throttling range overcomes *cyclic* or *hunting* action caused by *over-sized* control valves or other conditions existing in the system making *lined-out* pressure control difficult.

The H-W Type 1400 Pressure Pilot assures performance matching other H-W Control Equipment used throughout the Refining, Chemical, Synthetic, Gasoline, Recycling and Power Industries and is adaptable for:

- Vacuum Relief Control
- Vacuum Control
- Back-pressure Control
- Reduced Pressure Control
- Fluid Pressure Control
- Pump Governor Control
- Boiler Fuel Governor Control or any other installation where pilot operation makes for greater sensitivity and smoother control.

Write for Operation Bulletins describing H-W Pressure Control Pilots, giving us detailed information of your control requirements.

STANDARD FOR *Performance*

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HIGHER CUTTING EFFICIENCY from SEISMOGRAPH BITS

Hard-Facing Recommendations For Obtaining More Footage—Faster Cutting—Less Down-Time For Bit Resharpening

1 Always include at least one Borium insert at the lower, outside corner of each cutting wing to prevent "diamond pointing." (Sketch)

2. On bits larger than 6 inches O.D a second Borium insert on the lower cutting edge improves drilling efficiency. (Sketch)

3. Cover leading faces of all bit wings with Tube Borium, using screen size of at least 10-20 mesh rather than finer meshes such as 30-40. Tests conclusively prove the larger Borium particles greatly increase drilling speeds.

4. Don't skimp on quantity. Tests show that bit life and efficiency is in direct proportion to the amount of Tube Borium applied (up to 1/8" in thickness).

More Seismograph Bits Are Hard-Faced With Tube Borium Than Any Other Alloy

STOODY COMPANY

1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear . . . Eliminate Repair

LAUGH WITH BARNEY

A shoulder strap is a piece of ribbon worn to keep an attraction from becoming a sensation.

* * *

The Department of Taxation received a typed income tax return from a bachelor who listed one dependent son. The examiner returned the blank with a penciled notation—"This must be a stenographic error." Presently the blank came back with the added pencil notation, "You're telling me!"

* * *

Some noisy relatives were visiting a couple and happened to mention their dog, a big mongrel.

"He's just like one of the family," said the pup's proud mistress.

"Which one?" asked the hostess.

* * *

Mother: Do you know what happens to little girls who tell lies?

Betty: Yes. They grow up and tell their little girls they'll have curly hair if they eat their spinach.

* * *

Liza: So yo' husbin' done jine de Ahmy? Whut's he doin'?

Mandy: Dey done made him gunnah —jes lak he's always been.

Liza: When's he evah done any gunnin'?

Mandy: Ah means he's always gunnah do dis an' gunnah do dat, an' he's nevah done nothin'.

* * *

Judge: You say you have known the defendant all your life. Tell the jury whether you think he would be guilty of stealing this money.

Witness: How much was it?

* * *

A doctor who had taken up as his specialty the treatment of skin diseases was asked by a friend how he happened to select that particular branch of medicine.

"There were three perfectly good reasons," replied the physician. "My patients never get me out of bed at night, they never die, and they never get well."

* * *

A hypochondriac, after reading the daily medicine column, in wild alarm telephoned his doctor that he was sure now he had a fatal liver disease.

"Nonsense!" protested the doctor. "You wouldn't know whether you had that or not. With that disease there is no pain or discomfort of any kind."

"I knew it!" gasped the patient. "My symptoms exactly!"

Mrs. White: Mrs. Gray's husband didn't leave her much when he died, did he?

Mrs. Black: No, but he left her often while he was alive.

* * *

"Do you mean to say your husband beat you when you arrived home after midnight?"

"Yes—but only by 20 minutes!"

* * *

Sign on a display of tomatoes in a vegetable market: "Don't squeeze me till I'm yours."

* * *

Engineering Professor: Are there any questions?

Freshman: Yes, sir. How do you calculate the horsepower of a donkey engine?

* * *

Pilot (just after tailspin): I'll bet 50 percent of the people down there thought we were going to be killed that time.

Student Pilot: Yes, sir! And 50 percent of the people up here thought so, too.

* * *

"What is the Mason-Dixon line?"

"It's the division between 'you all' and 'youse guys'."

* * *

"My wife doesn't understand me. Does yours?"

"Dunno. Never heard her mention your name."

* * *

Engineering Problem

A cross-eyed woodpecker with a cork leg and a synthetic rubber bill requires 4½ hours to peck ¾ of the distance through a cypress log 53 years old. Shingles cost $0.79 per hundred and weigh 8 ounces apiece. The log being pecked upon is 34 feet long and weighs 46 pounds per foot. Assuming that the coefficient of friction between the woodpecker's bill and the cypress log is 0.097 J and that there is negligible resistance to diffusion, how many units of vitamin B-1 will the woodpecker require in pecking out enough shingles for a $7500.00 barn with detachable chicken house? The woodpecker has an efficiency of 97 percent and gets time and a half for overtime.

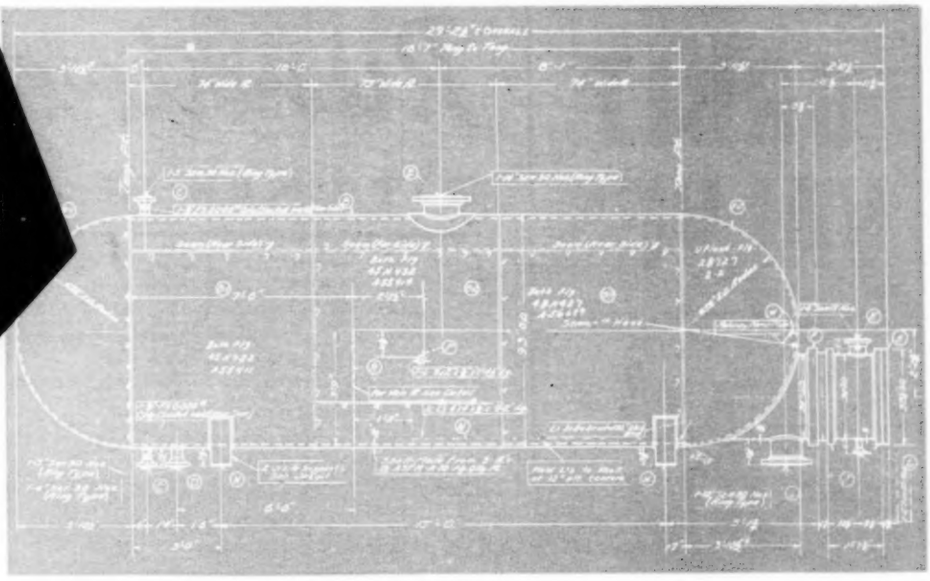
* * *

Definition: An ash tray is something to put cigarettes in when the room has no floor.

* * *

Then there was the little lady who was so dumb that she thought a goblet was a sailor's child.

From THIS



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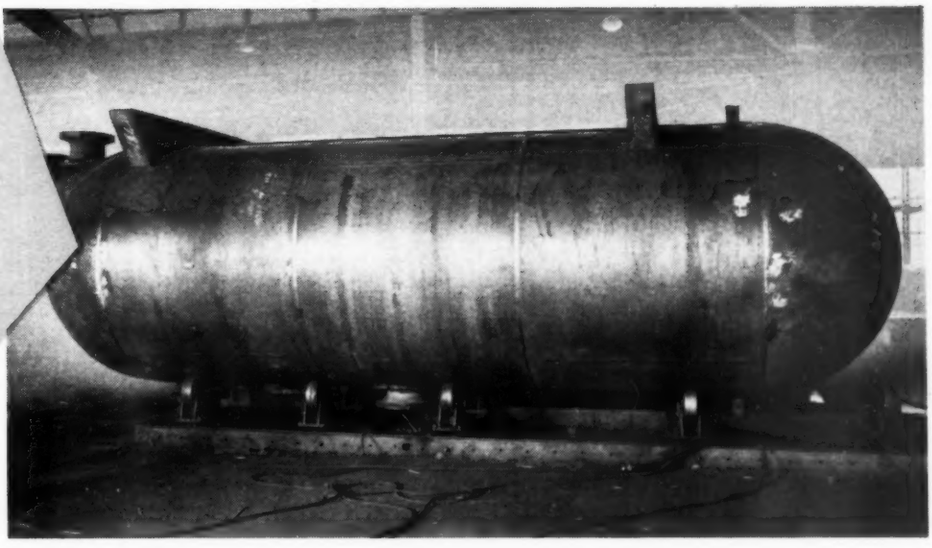


IN 17 DAYS

Deliveries on time win friends as does the quality workmanship that goes into each Maloney vessel.

Code stamped, each tank and vessel is also thoroughly inspected in Maloney's modern equipped plant.

Each customer's requirements are given prompt attention, and best of all deliveries are made on schedule.

Bolted Steel Tanks

Welded Steel Tanks

Oil & Gas Separators

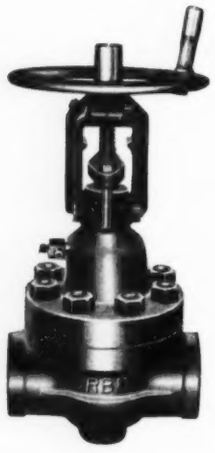
Pressure Vessels

MALONEY TANK MFG. COMPANY
38 N. Peoria, Tulsa, Oklahoma

MALONEY

ORBIT VALVES

ARE BUILT TO "TAKE IT"



ORBIT FLOW LINE VALVE

A full round opening valve that operates easily under high pressures. No grease required to effect a seal. Compact in design, yet built to "take it."

●

YOUR ORBIT VALVES will last for the duration. Meanwhile, if you have any questions regarding their care or maintenance, write us.

●

OIL WELL IMPROVEMENTS CO.

Since 1912

TULSA, OKLAHOMA

Running Tour

WITH MEN IN THE INDUSTRY

JACK P. MAGOFFIN, field representative for Hydril Company for 12 years, has accepted the position of district manager for Patterson-Ballagh Corporation of Los Angeles, California. Magoffin will be stationed at Houston, Texas, and will have the same territory that he covered for Hydril. He succeeds J. M. O'Melveny.

WILLIAM D. CRAMPTON, Naugatuck, Connecticut, has been appointed director of the foreign supply and distribution division of the Petroleum Administration for War in a reorganization of the entire foreign division. WILLIAM B. HEROY, Houston, Texas, is the new director of foreign production, and C. STRIBLING SNODGRASS, Martinsburg, West Virginia, is director of foreign refining.

E. V. MCCOLLUM and CRAIG FERRIS, both of whom have been associated with the Mott-Smith Corporation, Houston, Texas, have organized a new geophysical contracting firm. The company, which is called E. V. Collum and Company, will be located in the Thompson building, Tulsa, Oklahoma. Before joining Mott-Smith, McCollum was with Continental Oil Company as control geophysicist.

E. L. DECKER, vice president of Martin-Decker Corporation, Long Beach, California, has just completed a sales trip in the interests of his company. Kansas, Oklahoma, and Texas were visited and considerable time was spent in West Texas fields.

CARL M. HILL, former assistant field supervisor of the Lone Star Producing Company, has been promoted to the position of assistant chief production engineer, it was announced by L. T. Potter, superintendent of the department. Hill will act as assistant to E. A. Brown. MINOR O. ATTERBERY, JR., was named to the position of field supervisor replacing J. W. Burrage, who resigned, and AUSTEN J. HARGRAVE was appointed district production engineer for the East Central Texas district, formerly under Atterbery's supervision. NEIMAN C. SMITH, production engineer in West Texas district, succeeds Hargrave as district production engineer.

FRED H. TOWNSEND has been named superintendent of gasoline plants for Lone Star Producing Company to replace Harry Wheeldon, who resigned to join Shamrock Oil and Gas Company. Townsend has been associated with the company since 1922.

ANSON G. PHELPS, traffic manager of Standard Oil Company of New Jersey, is retiring under the company's annuity plan after 42 years of service. EDWARD D. SHEFFE, assistant traffic manager, moves up to take Phelps place. The retiring traffic chief has spent his entire business career with the company, beginning in 1901 as an office boy.

J. C. HUNTER, K. B. NOWELS, and J. C. HUNTER, JR., have organized a new firm specializing in oil production by water flooding. The firm, Hunter, Nowels and Hunter, has its headquarters in the Mims Building, Abilene, Texas.

CARY P. BUTCHER is to have charge of operations for the Richfield Oil Corporation in the new West Texas-Southwest New Mexico district. GEORGE R. GIBSON will be district geologist and MRS. W. S. NELSON will be in the office, which has been established at Midland, Texas.

HARVEY A. CRAIG has been appointed district sales manager of Republic Steel Corporation in the Los Angeles district, it was announced by N. J. Clarke, vice president. ARTHUR C. GELDNER will be assistant sales manager in this territory. Craig was vice president of Rheem Manufacturing Company, Richmond, California, for many years.

JOSEPH A. HUTT, Deep Rock Oil Corporation, was named chairman of the new Drumright, Oklahoma, chapter, division of production, American Petroleum Institute, and THAD A. HILL, Fluid Packed Pump Company, was named secretary-treasurer. A permanent organization will be set up at the next meeting.

E. LELAND CLARK has been appointed sales manager in the Dallas, Texas, office territory of the Walworth Company, Inc., it was announced by Fred W. Duemler, vice president. He succeeds the late Chester L. Bradbury.

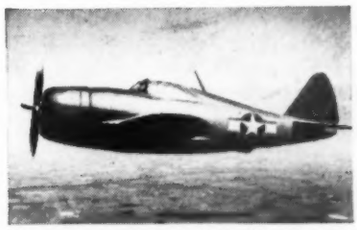
Kellett parts are helping Curtiss P-40 Warhawks to crush the Axis in combat

Pioneered the Past . . .
ENGINEERING THE FUTURE

In addition to producing rotary wing aircraft for the armed forces, Kellett's five plants are supplying important parts requiring highest skill and aircraft manufacture "know how" for our nation's best bombers and fighters . . . including the Consolidated B-24 Liberator, the Martin B-26 Marauder, the Republic P-47 Thunderbolt and the Curtiss P-40 Warhawk.

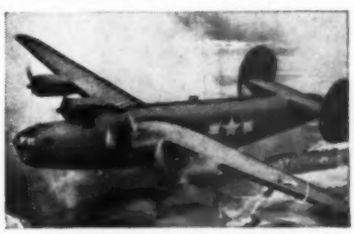
Meanwhile Kellett's *expanding* engineering staff continues the necessary development of *autogiros* and *helicopters* in cooperation with the United States Army Air Forces to meet present and future military requirements.

We look forward to postwar opportunities for Kellett Rotary Wing Aircraft to serve in patrolling electric power lines, oil pipe lines and in a variety of time-saving and cost-cutting operations for industry, commerce, forestry and agriculture. Kellett Aircraft Corporation, Upper Darby (Philadelphia), Penna.



Kellett precision-made parts are flying with the famous Republic P-47 Thunderbolts

Kellett products accompany the powerful, high-speed Martin B-26 Marauders



... and ride with long-range Consolidated B-24 Liberators over Germany

K E L L E T T

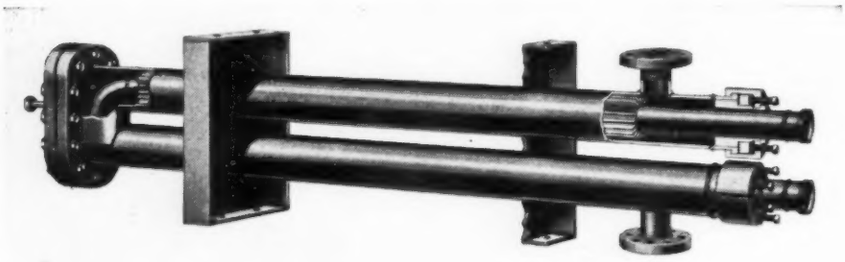
OLDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY

MACHINERY and EQUIPMENT

Improved "Sectional" Heat Exchanger

THE Brown Fintube Company of Elyria, Ohio, manufacturers of resistance-welded integrally-bonded fintubes, and fintube heat exchangers, has introduced an improved construction of the popular and widely used "sectional hairpin" heat exchanger.

Featured in these new Brown fintube "section" exchangers is a non-removable rear end assembly. The operator is required only to remove the bolts, back the cover plate off far enough to clear the plates of the adjacent "section," then swing the plate through a 180° arc, and rebolt it in this position, to gain clear, unobstructed entrance into the exchanger. According to a company spokesman, this greatly simplifies installation and maintenance, as it avoids the use of any heavy, cumbersome members, to take off, lower to the ground, and then raise back and put on again. It also makes inspection and cleaning quick and easy, and therefore not so likely to be "overlooked." This easy accessibility to the interior of the unit also permits hairpins employing "plain longitudinal" or "cut and twisted" fintubes having different ratios of "secondary to primary" surfaces and different heat transferring capacities to be interchanged one for another as desired, so that a single "stand" of these improved "sections" can be used for a variety of different duties.



The new "head" seal introduced in these new exchangers, consisting of a solid ring and 2 split collars tightened with cap screws, can be assembled easily with only a conventional 8-in. crescent wrench. This construction is said to avoid any outboard stress on the split ring lock, and tests using a solid copper gasket are said to have shown this construction capable of holding in excess of 2000 lb. pressure for days without trace of "weeping."

In addition, these new exchangers have welded one-piece "hairpins" that prevent mixing of the tube-side and shell-side commodities; and through the use of Brown fintubes assures users of high thermal efficiency and trouble-free operation, according to the manufacturer.

Greater details, including dimensions, rated duties, etc., of standard sizes of these new "sectional" exchangers, using Brown "plain longitudinal" and "cut and twisted" fintubes, and other details of interest to works managers, superintendents, and other operating men, are contained in a new bulletin, copies of which can be obtained by writing The Brown Fintube Company, Elyria, Ohio.

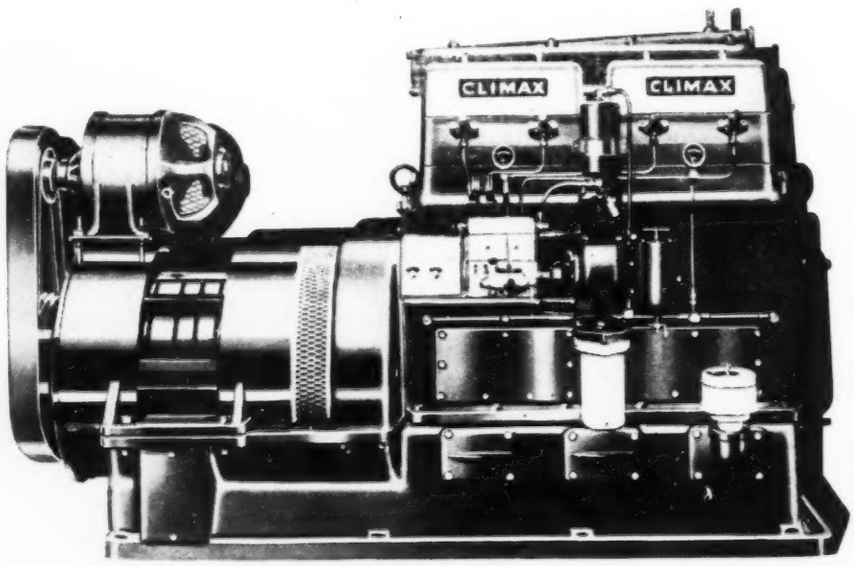
Adds to Engine Line

THE production of two solid injection, compression ignition engines has been announced by Climax Engineering Company, Clinton, Iowa. These prime movers are additions to the company's extensive line of Blue Streak gas engines, 8 to 480 hp., generating sets, 300 watts to 312 kva., and complete accessory equipment.

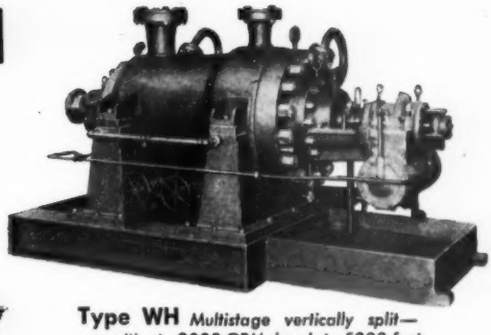
Both new engines are 4-cycle, full Diesels and intended for use as light plants and primary drives for pumps, compressors, mills, mine equipment, marine service, etc.

Model D148 is a 2-cylinder unit with a maximum rating of 22 hp. It may be equipped for pulley drive with or without clutch or clutch and reduction gear or auxiliary power take-off. As a Diesel electric plant it may be direct connected, on a single base, with a 15 kva. generator.

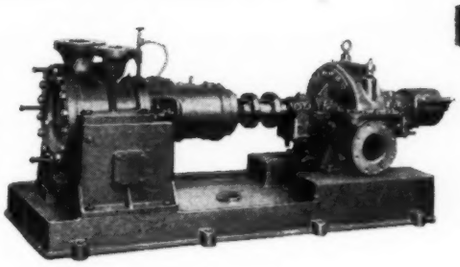
Model D297 is a 4-cylinder unit with a maximum rating of 44 hp. Drive equipment similar to Model D148 may be supplied. A special feature of D297, however, is that a flywheel, clutch, generator, or marine gears may be installed on either or both ends, providing a radiator is not used. For electric power and light, the D297 may be used to power a 30 kva. generator.



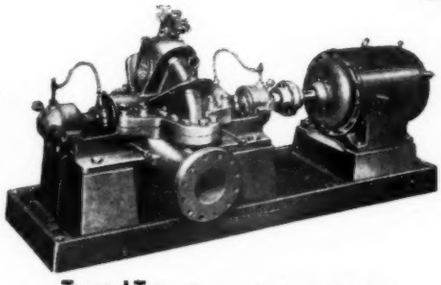
WORTHINGTON



Type WH *Multistage vertically split—capacities to 2000 GPM, heads to 5000 feet*



Type H *Single-stage vertically split—capacities to 2000 GPM, heads to 700 feet*



Type LT *Single-stage horizontally split—capacities to 2500 GPM, heads to 500 feet*

COMPLETE COVERAGE in Refinery Centrifugal Pumps

Worthington offers the petroleum refinery the most complete line of modern *service proven* centrifugal pumps for all refinery applications.

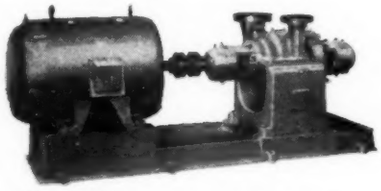
This line includes vertically and horizontally split process pumps, single and multistage Monobloc and coupling drive, with correct materials to meet every condition and preference.

With companion lines of up-to-the-minute reciprocating steam, power and rotary pumps, Worthington's position is unsurpassed in its preparedness to furnish *the correct pump for every refinery service.*

The types shown are but representative of the extensive Worthington line . . . many others are available.

MEMBER

Type DHL *Single-stage vertically split monobloc—capacities to 1000 GPM, heads to 250 feet*

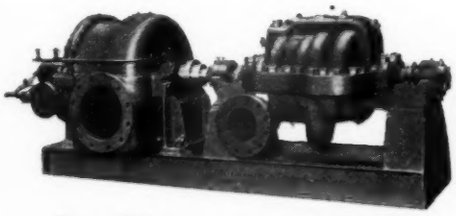


Type HE *Two-stage vertically split—capacities to 700 GPM, heads to 1500 feet*

ANY TYPE OF DRIVE

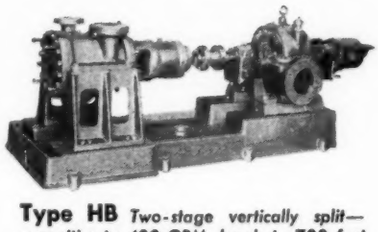
Electric Motor • *Steam Turbine* • *Diesel or Gas Engine*

Both the Navy E and Army-Navy E Awards have been presented to Worthington for speed and excellence in production.

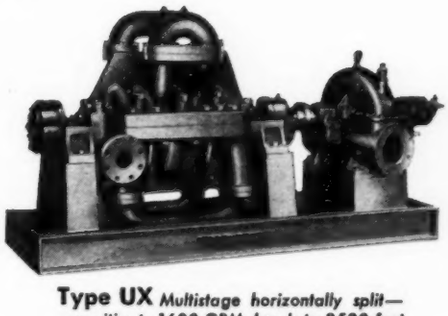


Type UV *Four-stage horizontally split—capacities to 1200 GPM, heads to 1500 feet*

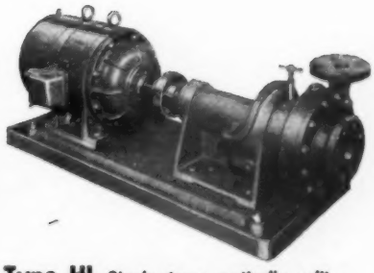
CP3-1



Type HB *Two-stage vertically split—capacities to 400 GPM, heads to 700 feet*



Type UX *Multistage horizontally split—capacities to 1600 GPM, heads to 3500 feet*



Type HL *Single-stage vertically split—capacities to 1000 GPM, heads to 250 feet*

Self-Priming Pump

AN IMPROVED automatically controlled valve is a distinctive feature of the new Type AO self-priming pump announced by Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin. The design and operation of its valve arrangement is an important factor in the quick and effective self-priming action of this pump.

Priming of the Type AO pump is accomplished as the motion of the water through the pump runner and the volute passage carries behind it a slug of air, drawing air in the suction passage through the impeller and out through the priming chamber. This hydraulic action lifts the column of water in the suction line and achieves the same results as would a separate vacuum pump. The priming valve closes slowly during this process, acting against a spring tension that governs the rate of priming and the static height of the priming suction lift. The automatic closing of the valve after complete priming prevents water from bypassing back to the suction chamber, with resultant power loss.

The pump impeller has an unusually thick vane with rounded inlet edges, permitting the pump to pass stringy materials and fairly large solids.

Allis-Chalmers plans a complete line of the self-priming Type AO pump, from 1 to 6 in. size, although only 2 in. and 3 in. sizes are ready for immediate sale. The entire line of pumps will range from a very small capacity to 1400 gal. per min. and up to heads of 100 ft. or more. The self priming device incorporated in these pumps is also adaptable to use with other pumps, particularly the single suction type. Further details may be obtained by writing the manufacturer.

Specialized... FOR EXTRA HEAVY DUTY

AMERICAN HEAVY DUTY ROLLER BEARINGS are *specially* designed to provide continuous, trouble-free performance under the most severe, gruelling service conditions possible. Put AMERICANS into the heaviest, most powerful equipment built for the toughest kind of going, and they will function smoothly, flawlessly—requiring minimum maintenance for maximum periods—often outlasting the equipment itself. That's why, for more than 25 years, AMERICAN HEAVY DUTY ROLLER BEARINGS have been first choice with manufacturers and producers of oil country and industrial machinery.

Write for specifications or send us your requirements for analysis and recommendations.

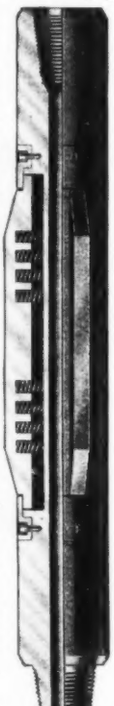
AMERICAN ROLLER BEARING CO.
PITTSBURGH, PENNSYLVANIA
Pacific Coast Office . . . 1718 S. Flower St., Los Angeles, California

AMERICAN ROLLER BEARINGS HEAVY DUTY

AMERICAN
Heavy-Duty ROLLER BEARINGS

Casing Scraper

THERE is always a hazard to downhole operations performed through casing when the inside wall of the pipe is not completely free of incrustations or projections of any kind. Tools may hang up or be tripped prematurely, packing elements may be damaged, slips may be clogged with cement and fail to hold, or subsequent strings of casing or liner may fail to go down. Even when a maximum gauge bit is used for drilling out cement left in the casing, some of the cement will remain on the wall of the pipe. Burrs are left when perforating and may damage cement retainers, packers, or other devices depending on a seal-off for their successful performance. Even soft material, such as paraffin, adhering to the wall of the casing may hamper operations. This is all particularly true when equipment with close clearance is run through the string or when the hole is even slightly off vertical.



To overcome this danger Baker Oil Tools, Inc., P. O. Box 127, Vernon Station, Los Angeles 11, California, developed a rotary casing scraper for the removal of all kinds of incrustations and projections on the inside wall of the casing. This tool is run on the drilling string (usually above the drilling bit) and scrapes the wall of the casing as it is rotated. The scraper is equipped with three blades that form an expansible reamer because they are at all times pressed outwardly against the wall of the pipe by a number of strong, coil springs. This design provides a self-adjusting and equalizing operation that affords uniform contact with the wall and insures a smooth scraping and cleaning action. The cutting edges of the blades are faced with hard metal.

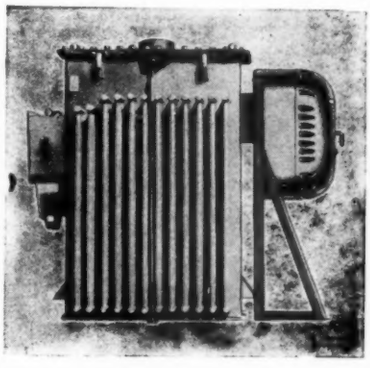
The blades are easily changed and a blade depressor adaptable to all sizes of casing scrapers can be supplied to facilitate the operation. There are recesses for eight springs under each blade but only the number of springs necessary to meet the scraping conditions need be used.

In operation, the rotary casing scraper is usually inserted between the drilling bit and the drill collar and is then lowered in the well until the section of casing to be scraped is reached, the blades riding against the wall of the pipe. When scraping, the tool is rotated as in normal drilling and the scraper automatically scrapes the wall of the casing of any incrustations and cuts and smooths out any projections. The blades will not only adjust themselves automatically to all weights of a given size of casing but will also pass through the joints of internal upset casing.

The casing scraper is frequently run above the bit when drilling out the cement tailings left in the casing during cementing operations, thus removing all the cement in one operation. It can, of course, be run at any time and is probably most extensively used for cleaning the wall of the casing after other operations have been completed at the depth to which the well has been drilled at that time.

Unit Substations

A LINE of load-center unit substations for semi-hazardous locations in oil refineries, chemical plants, and other plants having similar conditions, has been announced by the General Electric Company, Schenectady, New York. Available in standard ratings from 100 to 1000 kva. at 480 volts and 100 to 500 kva. at 208/120Y or 240 volts, these unit substations can be used indoors or outdoors for power and lighting service of 600 volts and less. Primary voltages from 2.4 to 15 kv. can be handled.



The new line incorporates a liquid-filled primary disconnecting switch, standard Pyranol or oil-filled transformer section, and a low-voltage section with a 600-volt, easily removable air circuit breaker. The units are completely metal-enclosed, coordinated, factory-built substations. All arcing parts are either liquid immersed or in enclosures of Class I, Group D, construction.

The transformer has four 2½-percent taps (two above and two below normal-rated high voltage, and for rated kva.) in the high-voltage winding. An externally operated, manual tap changer is supplied for operation only when the transformer is de-energized.

The incoming line switch is mounted integral with the transformer section and is equipped for breaking transformer magnetizing current. A key-type interlock works in conjunction with a similar lock on the low-voltage breaker to prevent the switch from being operated when load is on the transformer.

The low-voltage section is supplied with either a manually or an electrically operated main secondary air circuit breaker with time-overcurrent protection and instantaneous short-circuit trip. The circuit breaker is mounted in a Class I, Group D, metal enclosure.

Bulletin GEA-4085 describes this equipment in detail.

RUBBER PRODUCTS

AVAILABLE IN STOCK

V-BELTS

MULTIPLE DRIVE BELTS — MATCHED SETS

PARTIAL LIST OF SIZES

Belt Sizes A WIDTH	Belt Sizes B WIDTH	Belt Sizes C WIDTH	Belt Sizes D WIDTH
A-26	B-42	C-51	D-120
A-31	B-46	C-60	D-128
A-35	B-51	C-68	D-144
A-38	B-55	C-75	D-158
A-42	B-60	C-81	D-162
A-46	B-68	C-85	D-173
A-51	B-75	C-90	D-180
A-60	B-81	C-96	D-195
A-68	B-85	C-105	D-210
A-75	B-90	C-112	D-240
A-80	B-97	C-120	D-270
A-85	B-105	C-128	D-300
A-90	B-112	C-144	D-330
A-96	B-120	C-158	D-360
A-105	B-128	C-162	E WIDTH
A-112	B-144	C-173	E-180
A-120	B-158	C-180	E-195
A-128	B-173	C-195	E-210
	B-180	C-210	E-240
	B-195	C-240	E-270
	B-210	C-270	E-300
	B-240	C-300	E-330
	B-270	C-330	E-360
	B-300	C-360	

IMMEDIATE DELIVERY

RUBBER BELTING

HEAVY DUTY — SILVER DUCK — SQUARE EDGE

A.P.I. SPECIFICATIONS

Furnished in All Required Lengths

Width Ply	Width Ply
8" x 6	14" x 6
10" x 6	16" x 6
12" x 6	18" x 6

(Other Sizes Available)

RUBBER HOSE

All Types and Sizes for Use on

LOADING RACK, OXY-ACETYLENE WELDING, COMPRESSORS, STEAM, OIL, SUCTION, WATER, FIRE, PAINT, ETC.

FORMATION TESTER PACKER ELEMENTS

see page 576 Composite Catalogue

Furnish Details of Your Requirements . . . Prompt Quotations . . . Immediate Deliveries

CARLYLE RUBBER CO., INC.

62-64 PARK PLACE • NEW YORK 7, N. Y.

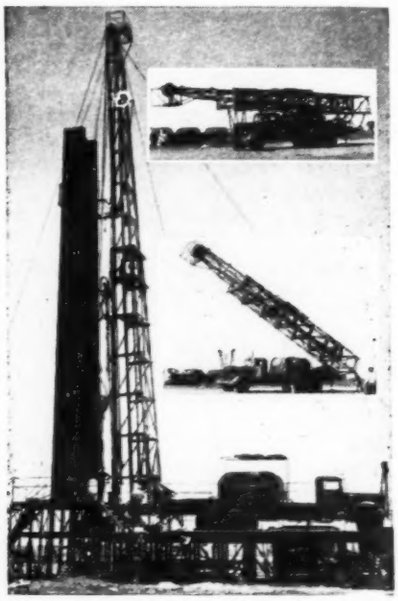
"Self-Propelled" Telescoper

CONTAINING all essentials for either drilling or servicing wells and mounted on a single truck, the Model 7000 double duty "self-propelled" telescoper made by the Franks Manufacturing Corporation, Tulsa, Oklahoma, brings added savings to the petroleum industry, states the manufacturer.

A Model 7000 now in service at Riverdale, California, contains a 96 ft. derrick, drawworks, power plant, rotary table, crown block, and stacking board as an integral part of the unit. Pumps for drilling operations are mounted on skids for handling by an auxiliary truck.

The Franks' derrick telescopes to 58 ft. for over-the-road travel with blocks and lines strung, reducing move-in and rig-up time to usually less than 45 minutes. Actual raising, extending, and locking the derrick requires less than 10 minutes. A patented power screw raising and lowering mechanism and a self-locking device feature the Franks' unit. The derrick is equipped for handling rods and racking drill pipe or tubing.

Designed for all-around use the unit will service wells up to 10,000 ft. in depth, is adaptable for deepening and clean out work, will handle shallow or medium depth standard drilling or deep

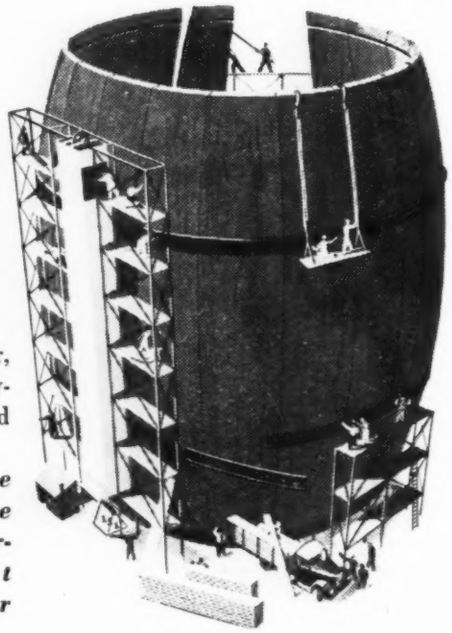


Telescoper in service in California with 7900 ft. of 2½ in. tubing racked. A sub-structure is used here to clear the elevated blowout preventer. Insets show unit in "over-the-road" position and with derrick being raised.

"slim-hole" drilling, it is stated. Being 100 percent portable it is especially desirable for exploratory drilling.

We built the barrel

BIG



EARLY in the war, the electric service industry received this challenge:

You will be asked to scrape the bottom of the barrel to haul out more kilowatts for war production!

But fortunately, we had built the barrel big!—Big enough to meet all the power needs of factories, mines and shipyards—and still supply your home—without rationing—at bargain prices!

Today, America is producing five times more electric power than in the last war — more than all the Axis countries combined!

Was it luck that built the barrel BIG? No. Southwestern Gas & Electric Company along with other business-managed electric companies supplying over 80% of the nation's power—look and plan ahead. That habit has helped us give you friendly, dependable service—and helped us meet the challenge of America-at-war!

SOUTHWESTERN GAS & ELECTRIC CO.

Water Testing Equipment

A NEW test set for boiler water control analyses is announced by W. H. and L. D. Betz, Philadelphia, Pennsylvania. The test set includes all the necessary apparatus and chemicals for the determination of hardness, alkalinity, chloride, sulphite, and phosphate. A special cabinet designed for use on table or wall is provided. All apparatus and chemicals are contained in the cabinet, held in a secure position and ready for instant use.

A portion of the opened cabinet door forms a convenient acid-resistant laboratory work table and a fluorescent light provides correct illumination for the tests. The protection afforded by the cabinet minimizes breakage and eliminates errors caused by dust and dirt.

A complete instruction book is included informing the operator how to perform the simple rapid tests and what the results mean in terms of plant control.

FOR SALE: Two-stage, direct gas driven air compressors—Bessemer 80 h.p. Type 9B, $1,500; Clark Bros. 100 h.p. Type S, $1,000; 2 Pattin Bros. 90 h.p. Ekonomy Type, $1,500; Ingersoll-Rand 80 h.p. Type 10, belt-driven, two-stage compressor, $800. All in good condition. Dean Bros., W. T. Waggoner Bldg., Fort Worth 2, Texas.

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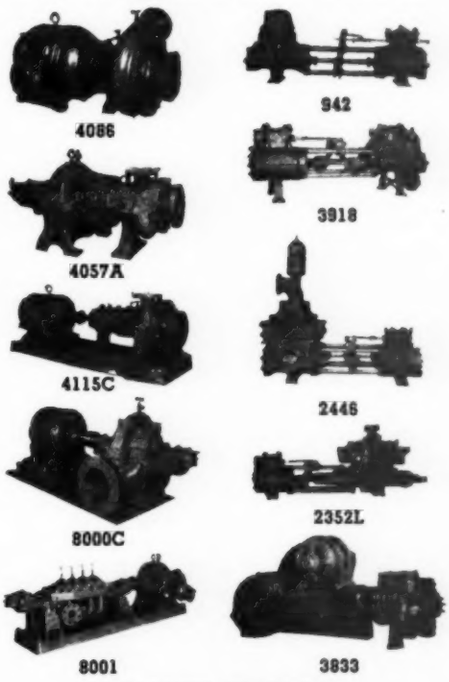

BRANCH OFFICES
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A.I.M.E. Science and Technical Meetings

In connection with the Texas Academy of Science's annual meeting, the Gulf Coast, East Texas, College Station, and University of Texas sections of the American Institute of Mining and Metallurgical Engineers jointly held a symposium on underground water problems November 12.

The symposium consisted of the following papers and discussions:

"Problems of Salt-Water Disposal in East Texas," by W. S. Morris and L. H. Dial, East Texas Salt Water Association.

"Quantitative Studies in Ground Water in Texas," by W. O. George and W. N. White, U. S. Geological Survey.

"Chemistry of Waters Encountered in the Frio Formation of the Gulf Coast," by F. W. Rolshausen and F. W. Jessen, Humble Oil and Refining Company.

"Micro-Organisms in Oil Field Waters (illustrated with lantern slides), Fred Barclay and F. B. Plummer, University of Texas.

"The Need for More Hydrology," by Paul Weaver, Gulf Oil Corporation.

"Geological Significance of Oil Field Waters and Their Relationship to Structure and Production," by W. R. Berger, consulting geologist and engineer, Fort Worth.

"The Closed System of the Handling and Disposal of Oil Field Waters," by I. W. Alcorn, chief production engineer, Pure Oil Company, Houston.

"Chemistry of Oil Field Waters with Special Reference to Water Disposal Problems," by F. B. Plummer and Paul Tapp, University of Texas.

McColl a Director

Robert B. McColl, vice president, manufacturing, American Locomotive Company, was elected a director of the company at the regular meeting of the board of directors, October 28.

R. B. McCOLL

McColl was born in 1882 at Kilmarnock, Scotland, where he attended the Kilmarnock Academy and the Science and Art College. After serving a special apprenticeship and working in various departments on the Glasgow and Southwestern he was employed by Robert Stephenson and Sons, locomotive builders, Darlington, England, as draftsman.

In 1905 he went to the Montreal Locomotive Works, Ltd., Montreal, Canada, and served in several departments until he became assistant superintendent, then superintendent of works, and finally works manager. In 1917 he was appointed manager of the munitions department of the Eddystone Munition Company, where he served until after the Armistice.

Returning to England he was appointed general manager of the Armstrong Witworth Company. McColl is still a member of the Institute of Mechanical Engineers, London, England.

In January, 1922, he became attached to the New York office of the American Locomotive Company. The following June he was appointed assistant manager of the Schenectady plant, and in January, 1925, manager of the plant. In 1931, he was elected president and director of the McIntosh and Seymour Corporation, Auburn, New York, a division of the American Locomotive Company, and when the McIntosh and Seymour Corporation was merged with the parent company, McColl was appointed vice president of the American Locomotive Company, Diesel Engine Division. In 1936 he was elected president of the Alco Products, Inc., a division of the American Locomotive Company, and later vice president of the American Locomotive Company, Alco Products Division.

Exclusive Advantages of

NIXON SURFACE CONTROL GAS-LIFT SYSTEM

Years of experience and hundreds of installations operating under extremely varied producing conditions have proven these features enable production of large or small volumes at lowest possible cost.

CONTROLLED FREQUENCY OF LIFTS

Time control, made possible by the intermitter on the surface permits precise regulation of the intervals for admitting fluid-lifting gas into the tubing. Knowing the rate of fluid entry into the well, you will always have a uniform column of fluid in the tubing to be raised with every gas injection.

SURFACE CONTROL

Enables you to regulate the volume of flow, and the depth from which the well is to be produced, and which in most cases permits depletion of the well without changing or adding to sub-surface equipment.

LOW COST INSTALLATION

Having no heavy equipment, the Nixon Gas-Lift can be moved onto location in a small pick-up truck—installed without building an extensive foundation or the use of heavy machinery.

LOW GAS-OIL RATIO

By being able to control the level from which lift originates, it is necessary to inject only sufficient gas to raise the column of fluid to the surface. Allowance may also be made for the expansion of gas as it travels up the tubing. This eliminates any excessive, wasteful use of gas to lift the fluid to the surface.

ECONOMICAL OPERATION

Repairs and maintenance are practically nil with this system. One man can take care of many units.

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BRANCH STORES: TEXAS — Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi. LOUISIANA — Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS: Magnolia. MISSISSIPPI: Natchez.

SALES OFFICES: Tulsa, Oklahoma; Dallas, and Beaumont, Texas
LOS ANGELES: Western Pressure Control, 5700 Santa Fe Avenue
TRINIDAD, B.W.I.: Neal Massey Eng. Corp.

Second Star for Kerotest

A second gold star has been added to the Maritime "M" pennant of Kerotest Manufacturing Company, according to a communication from Admiral Howard L. Vickery, vice chairman of the U. S. Maritime Commission. The award indicates continued outstanding achievement in the production of steel valves for use on the Commission's cargo vessels and tanker fleet, and also for use in the Navy's destroyer escort and landing ship program.

Kerotest originally received the Maritime "M" in August, 1942, and was awarded a six-months renewal with an added gold star for the "M" pennant in May of this year. Since the award in May, Kerotest has increased the number of its employees more than 20 percent, according to W. G. Swaney, general manager of the company.

Open Office

The opening of another Pacific Coast factory branch office has been announced by officials of The Cooper-Bessemer Corporation, 110-year-old engine builders whose plants at Mount Vernon, Ohio, and Grove City, Pennsylvania, have recently added a gold star to their Maritime Pennant for continued outstanding production.

The new office, at 401 Rust Building, San Francisco, California, is the third of three branches serving the west coast area. The other two offices have long been established at Los Angeles, California, and Seattle, Washington.

According to company spokesmen, the new San Francisco branch, under the local supervision of service representative John G. McKissick, will facilitate the installation and maintenance of Cooper-Bessemer diesel engines in army and navy vessels constructed in the northern California territory.

McEvoy Honored

McEvoy Company, Houston, Texas, was presented on October 29 the Army-Navy "E" Flag. George A. Butler, counsel for McEvoy Company, was master of ceremonies. Col. Merle H. Davis, chief of the St. Louis Ordnance District, presented the award, which was accepted by Gus S. Wortham, president of McEvoy Company. In his acceptance speech, Wortham lauded the leadership of B. T. McNeil, executive vice president, W. O. Hedrick, vice president in charge of production, the engineering staff, and the skilled workmen whose ingenuity made possible the designing of special machines out of other machines and who made a national record manufacturing complicated and extremely close-tolerance machine gun mounts. Lieut. Comdr. James G. Clark, U.S.N.R., expediting officer of the naval materials office, presented the "E" insignia to employee representatives.

McEvoy Company was doubly honored when its chief engineer, Robert Eichenberg, was presented an "Ordnance Citation" for designing a new space and weight saving crate for packing machine gun mounts, an accomplishment that Major Gen. L. H. Campbell, Jr., chief of ordnance, praised as a, "marked contribution to the vital war production of the United States." Eichenberg was the first Texan, and the 101st American to receive this citation, which was presented by Capt. F. P. Calabrese.

McNeill said McEvoy Company continues to keep its customers in the essential oil industry supplied with its regular oil field products, tubingheads, casingheads, self-operating gas lifts, and related products, and that after victory, the company will be ready with a line of tools of advanced design, manufactured to the close tolerances of McEvoy's precision war work.

HILL-HUBBELL

SPECIFICATION TAX-1

LET US RECALL TO YOU
the HILL HUBBELL process
of Steel Pipe Protection

Illustration shows the SIX successive steps in SPECIFICATION TAX-1, so widely used by gas and oil engineers.

Main line of corrosion defense is the thick, DOUBLE APPLICATION of BITURINE ENAMEL under the bonded asbestos felt, a sound, unique practice consistently followed since 1928.

Include the proven HILL-HUBBELL Process of Steel Pipe Protection in your post-war construction plans!

HILL-HUBBELL Steel Pipe Protection is applied at these leading mills:
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• EXPORT OFFICE SAN FRANCISCO, CALIFORNIA, U. S. A. •

Thermoid Acquires Stokes Rubber

Fred Schluter, president of Thermoid Company, Philadelphia, Pennsylvania, has announced completion of Thermoid's acquisition of the Joseph Stokes Rubber Company.

With the acquisition of the Joseph Stokes Rubber Company in Trenton and its subsidiary in Welland, Ontario, Canada, Thermoid's combined sales for the year 1943 should exceed $19,000,000, making it one of the largest rubber companies in the East.

As many of the products manufactured by Joseph Stokes Rubber Company in Trenton can be sold by Thermoid's Industrial Rubber Products Division, it is expected that the sales administration of Stokes will be supervised by Thermoid. W. J. B. Stokes II will remain as president of Joseph Stokes Rubber Company, devoting most of his time to manufacturing and engineering problems in that factory.

No change in the sales methods of Joseph Stokes Rubber Company Limited of Canada are contemplated. Lloyd R. Leaver, vice president and general manager of Stokes' Canadian plant, at one time acted as sales manager for Thermoid's Industrial Rubber Products Division. As Stokes of Canada sells largely to the same branches of the trade, there will be close collaboration between the Detroit Original Equipment Division of Thermoid and Stokes of Canada management.

Join Asphalt Institute

Ten additional asphalt producing companies have been elected by the board of directors of The Asphalt Institute, bringing the total number of companies constituting its membership to 37. Following is a list of the new members: Bell Oil and Refining Company, Los Angeles, California; Exeter Refining Company, Long Beach, California; O. C. Field Gasoline Corporation, Los Angeles; Five C. Refining Company, Los Angeles; Gilmore Oil Company, Los Angeles; Golden Bear Oil Company, Los Angeles; Inland Empire Refineries, Inc., Spokane, Washington; Kanotex Refining Company, Arkansas City, Kansas; The Petrol Corporation, Los Angeles, and Wasatch Oil Refining Company, Salt Lake City, Utah.

To cover the southern California territory more intensively, an Institute office has been established in Los Angeles. The address is 403 Pacific Mutual Building, 523 West Sixth Street, Los Angeles 14, California, and Arthur H. Benedict has been appointed engineer in charge.

Link-Belt Promotions

W. C. Carter, president, Link-Belt Company, Chicago, Illinois, announces the following promotions:

Edward J. Burnell, heretofore vice president and general manager in charge of Pershing Road plant operations and central division sales, has been transferred to the executive office of the company, 307 North Michigan Avenue. In his new position he will be vice president in charge of sales for the entire Link-Belt Company.

Directly assisting Burnell in his new post will be Nelson L. Davis, sales manager for materials handling machinery; William K. Kinkead, sales manager for power transmission machinery and C. Walter Spalding, sales manager for power transmission equipment required by original equipment manufacturers and duplicate machinery accounts.

Harold L. Hoefman, manager of the company's Atlanta plant, succeeds Burnell as general manager of the Link-Belt Pershing Road plant in Chicago.

Richard B. Holmes, district manager at Indianapolis, has been appointed manager of the Atlanta plant to succeed Hoefman.

David E. Davidson, district engineer at the company's Detroit office, has been named district manager at Indianapolis to succeed Holmes.

with *Reilly* PIPE ENAMEL

● The many miles of "Little Big Inch" that are coated with REILLY Pipe Enamel are dependably protected against all pipe line "saboteurs." The tough, durable REILLY coating prevents corrosion from moisture, electrolysis, soil acids or alkalies; resists abrasion and soil stress, and withstands extremes of heat and cold without sagging or cracking.

The dependable protection which REILLY Enamel gives to pipe lines has been proved by years of service on thousands of miles of installation—under all conditions of soil and weather. Booklet describing Reilly Protective Coatings will be sent on request.

Reilly COAL TAR PRODUCTS

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Executive Offices: Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS · 500 FIFTH AVENUE, NEW YORK, N. Y. · ST. LOUIS PARK, MINNEAPOLIS, MINN.

SEVENTEEN · PLANTS · TO · SERVE · YOU

Synthetic Rubber Belting

The beginning of volume production of industrial belting made with synthetic rubber has been announced by United States Rubber Company at its plant in Passaic, New Jersey.

This program of mass manufacture of synthetic rubber belting is designed to alleviate the shortage of transmission and conveyor belting that threatened war industries when sources of natural rubber were shut off with the capture of the plantations by the Japanese in the southwest Pacific.

This method consists of the application of synthetic rubber being forced into the pores of the fabric through the use of rollers. It is then fabricated into whatever sizes are necessary to meet the desired requirements.

Vulcanizing consists of a heat treatment that reaches a temperature of 287°F. The entire fabricating process depends on the work for which the belt is designed.

La.-Ark. Group Re-elects

The Louisiana-Arkansas group of the Mid-Continent Oil and Gas Association re-elected all officers for another year at its annual meeting in Shreveport, Louisiana. A sixth vice presidency was created and B. A. Hardy, independent operator, named to the office.

Officers re-elected are: President, A. H. Tarver, independent operator; vice presidents, J. J. Frommer, Ohio Oil Company; J. G. Goodman, Gulf Refining Company; D. W. Harris, Arkansas Natural Gas Company; C. H. Lyons, Lyons and Prentiss, and L. M. Moffitt, Triangle Drilling Company; secretary-treasurer, A. R. Campbell.

Electric Association to Meet December 1-2

The annual meeting of the Petroleum Electric Power Association will be held December 1 and 2 at the Baker Hotel in Dallas, Texas.

The association is comprised of more than 30 utility electric power companies who serve the petroleum industry.

This year's meeting will be open only to the members of the association and representatives of other utility electric power companies serving the petroleum industry.

Dehydro Company Announces Changes

The Dehydro Company, Tulsa, Oklahoma, announces an addition and change in its field staff.

Harry Horton, sales manager for The Dehydro Company, announces J. B. (Bo) Robinson as Tulsa district manager for the company. Before joining The Dehydro Company Robinson was for a number of years a gauger for the Stanolind Pipe Line Company in West Texas. Later he was district foreman for the Forest Producing Company, covering the first water flooding projects in the Big Creek area.

Horton also announced that W. M. (Bill) Best, who represented the company for 6½ years in the Seminole-Ada and Tulsa districts is now located in the eastern Kansas district with headquarters at Eldorado, Kansas.

Goodrich Appointments

Chester F. Conner has been named assistant general manager, and Fred Lang merchandise manager of the industrial products sales division of The B. F. Goodrich Company, it is announced by E. F. Tomlinson, division general manager. Conner had previously been merchandise manager, Lang, manager of sole and heel sales.

A graduate of Buchtel College in Akron, Conner has had more than 33 years of company service, all in the industrial products sales field. Lang joined the company in 1925.

PUT "CLEVELANDS" ON YOUR WAR EMERGENCY PIPELINE JOBS—

Whether It's:—

Long Main Lines—Gathering Lines or Loops—"Hot-Spot" Reconditioning—Stripping Pipe for Reconditioning and Relaying—Short Scattered Field Lines or Ordinary Maintenance.

In today's pipeline construction programs, Speed, Endurance, Low Cost operation and Service are the most essential machine requirements. That's why "CLEVELANDS" fit so perfectly into the picture and are preferred equipment on so many war and civilian emergency projects, current and recent. Geared to the job "CLEVELANDS" are delivering maximum performance, day in and day out, at rock bottom costs.

THE CLEVELAND TRENCHER CO.

"Pioneer of the Small Trencher"

20100 ST. CLAIR AVE. • CLEVELAND, OHIO

"CLEVELANDS" Save More . . . Because they Do More

Oil Men in QMC Fuels and Lubricants Division

Seventy-one different oil companies —24 major concerns and 47 independents—are represented among the approximately 100 officers now on duty in the Fuels and Lubricants Division, Office of The Quartermaster General, according to the War Department.

Aside from army career men and several officers in purely administrative positions, the military personnel is made up of officers with many years of practical experience either in the petroleum, coal, or packing industries.

As petroleum products in some form —gasoline, diesel, fuel, lubricating oils, and greases—represent the major portion of the division's procurement and distribution program, most of the officers ordered to active duty have been drawn from the petroleum industry. Those charged with the responsibility for handling solid fuels were recruited from the coal industry, and those dealing with fuel containers came from those branches of American business.

The largest representation for any one company is made up of 12 officers who previously were associated with The Texas Company. This record is almost equaled by the 10 officers from the Standard Oil Company of New Jersey, and 9 drawn from the Shell Oil Company, Inc.

Other large oil companies represented by one or more officers include Cities Service, Gulf, Phillips Petroleum, Richfield, Sinclair, Socony-Vacuum, Standard Oil of California, Indiana, Louisiana, Ohio, and Pennsylvania, Continental, Barnsdall, Humble, Magnolia, Mid-Continent, Pure, Skelly, Tide Water Associated, and Union of California.

Officers previously associated with independent oil companies represent virtually every section of the United States that produces oil, as well as major storage and distribution centers.

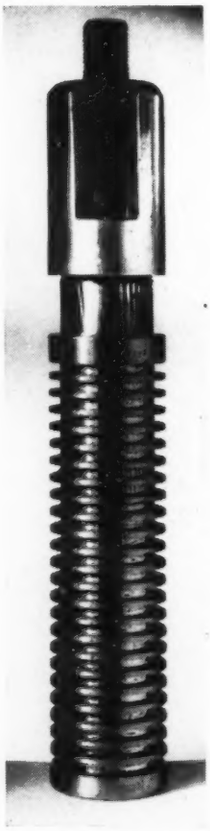
Longer Life Means Lower Pump Cost.... MARTIN PLUNGERS

Pumping equipment, like petroleum, is precious today. It must work longer hours; produce more oil. This is only possible through longer service, less wear, tear and repair.

Martin Plungers, designed for longer life under the toughest conditions, are ideal for wartime service. With the famous one-piece body—an exclusive Martin feature — and Martin's split composition rings, Martin Plungers last two to five times longer—save up to 85%.

Sold Only Through Supply Stores

See Composite Catalog



Martin Plunger Body After Four Years Use.

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Field Representatives:

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C. J. Baeten, Wichita, Kans.
Lynn C. Holloway, Houston, Texas
Hugh Robinson, Blackwell, Okla.
F. M. Wilson, Wichita Falls, Texas
J. Walter Wade, Chicago, Ill.
E. C. Dilgarde, Casper, Wyoming

Makes Statement

John Hauerwaas, president of United States Steel Products Company, recently issued the following statement:

"There has been some misunderstanding with regard to the type of product manufactured at the plants recently purchased from The Petroleum Iron Works Company situated near Sharon, Pennsylvania, and at Beaumont and Port Arthur, Texas.

"At one time Petroleum Iron Works made heavy bolted, riveted and welded tanks in addition to steel barrels, drums, and pails. When acquired, however, only the latter three types of products were manufactured, facilities for fabrication of heavy plate work having been previously disposed of. These plants now operated by Petroleum Iron Works Division of United States Steel Products Company are manufacturing only steel barrels, drums, and pails."

Link-Belt Buys Plant

Announcement is made by W. C. Carter, president, that Link-Belt Company has purchased the manufacturing plant and inventory of Link Belt Supply Company in Minneapolis, Minnesota, and that Ray S. Wood has been appointed plant manager.

Link Belt Supply Company had worked very closely with Link-Belt Company since 1900, having in all this time served as an authorized distributor of Link-Belt Company products in Minneapolis, St. Paul, and the adjacent territory.

The entire Minneapolis organization will be retained, present manufacturing facilities will be improved, and stocks are to be expanded as rapidly as possible, it is stated.

Wood, the new plant manager, started his Link-Belt Company career in 1914, in the engineering department at the company's plant in Philadelphia. He received his early engineering training at Drexel Institute, Philadelphia, and since 1925 has been district manager of the Link-Belt positive drive division, with headquarters in Detroit.

A.I.M.E. Meeting Attracts Interest

Discussions of particular interest to the petroleum industry at this time were presented at the annual fall meeting of the Southern California Section of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers held at the Ambassador Hotel, Los Angeles, October 21 and 22, 1943. The meeting consisted of technical sessions and an informal stag dinner. The papers and symposiums were as follows:

THURSDAY AFTERNOON
TECHNICAL SESSION
Chairman: N. L. Dorn
Co-chairman: E. G. Trostel

Introduction of C. A. Warner, chairman, Petroleum Division, A.I.M.E.

"Fingering and Coning of Water and Gas in Homogeneous Oil Sand," by M. G. Arthur, Union Oil Company of California.

"A Statistical Approach to the Interstitial Characteristics of Sand Reservoirs," by Jan Law, Dominguez Oil Fields Company.

"Optimum Time to Bail and Wash Wells Producing Sand," by J. R. Stitt, Western Gulf Oil Company, presented by E. W. McAllister, Western Gulf Oil Company, as Mr. Stitt is in the U. S. Navy.

"The Precipitation of Asphalt Through Crude Oil by Flow Through Silica," by Dr. D. L. Katz, Herman Dykstra, Karl Ben, University of Michigan.

FRIDAY MORNING
TECHNICAL SESSION
Chairman: Carlton Beal
Co-chairman: Dean H. Sheldon

"Possible Application of Secondary Recovery Methods in California," by C. L. Moore, Office of Petroleum Administrator for War.

"Bituminous Sands and Shales and Partly Depleted Surface Sands as Sources of Additional Oil in California," by G. B. Shea, Petroleum and Natural Gas Division, U. S. Bureau of Mines.

Symposium on Problems of Artificial Stimulation of Production by Water Drive. Discussion led by: F. M. Cole, Honolulu Oil Corporation; W. S. Morris, East Texas Salt Water Disposal Company; Norris Johnson, General Petroleum Corporation; C. B. McClintock, Petroleum Administrator for War; E. C. Babson, Union Oil Company.

"Flow Into Slotted Liners and Obstructed Core Samples," by C. R. Dodson and W. T. Cardwell, Standard Oil Company of California.

FRIDAY AFTERNOON
TECHNICAL SESSION
Chairman: A. G. Loomis
Co-chairman: Marshall C. Turner

"Oil and Gas in the Great Lakes and How They May Be Developed," by Henry Emmett Gross. The background of the paper is based on construction of marine foundations in California and includes marine drilling.

"State Legislation and the Oil Industry of California," by R. P. McLaughlin, consulting engineer.

"Gun Perforation for Multi-Zone Control in California," by T. H. Wallace, Western Gulf Oil Company.

"Rehabilitation and Dewatering Operations in the Kern River Field," by George O. Suman, Tide Water Associated Oil Company.

Symposium of Operations of Industries of the A.I.M.E., conducted by A. B. Campbell of Pacific Coast Borax Company.

After the technical sessions, cocktails were served in the Gold Room of the hotel from 7 o'clock until dinner was served at 8 o'clock. Following the dinner Walter D. Abel, chairman of the Southern California Section, presided and introduced various guests. Major Irving Krick, chief of Long Range Research Unit, Weather Information Branch, Army Air Forces, delivered an address on "War and Weather" illustrated by slides and followed by moving pictures.

BUILT WITH "GUTS" FOR EXTRA HEAVY DUTY
AMERICAN HEAVY DUTY ROLLER BEARINGS have built into them the vital extra capacity for continuous 24-hour-a-day performance under the most gruelling service conditions possible. Brutally strong . . . simply constructed . . . precise . . . AMERICANS operate quietly, smoothly, in the heaviest equipment under the most terrific strains and impacts. Longer, safer, lower-cost, trouble-free service is assured when AMERICAN HEAVY DUTY ROLLER BEARINGS are on the job. That's why most major manufacturers and designers of heavy industrial machinery and oil country equipment specify AMERICANS.
In your next heavy-duty installation, ride the load on AMERICANS. Our engineers will welcome your roller bearing problems. Write today.
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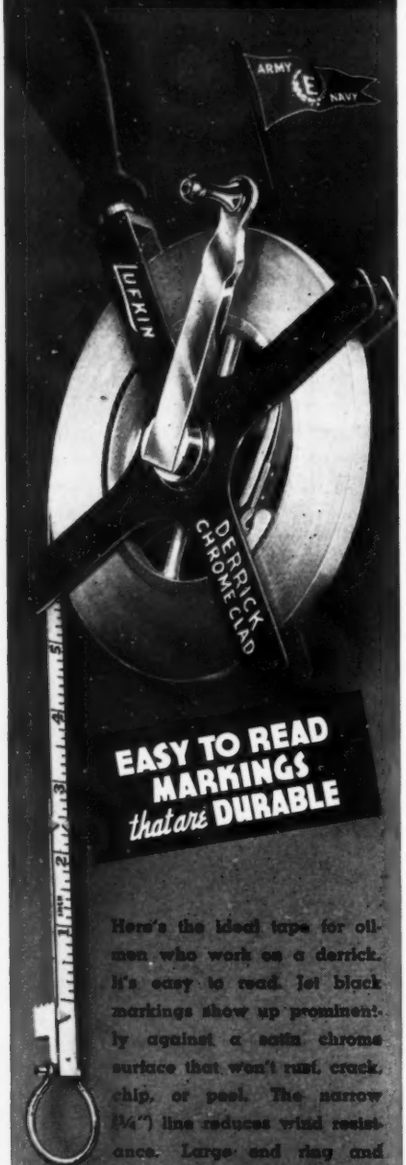
AMERICAN
HEAVY-DUTY
ROLLER BEARINGS

LUFKIN
"DERRICK"
CHROME CLAD
STEEL TAPES



EASY TO READ MARKINGS *that are* DURABLE

Here's the ideal tape for oil-men who work on a derrick. It's easy to read. Jet black markings show up prominently against a satin chrome surface that won't rust, crack, chip, or peel. The narrow (¼") line reduces wind resistance. Large end ring and hook permit rapid, accurate measuring of casing standing up-right in a derrick. Order from your supply house. Write for free catalog today.

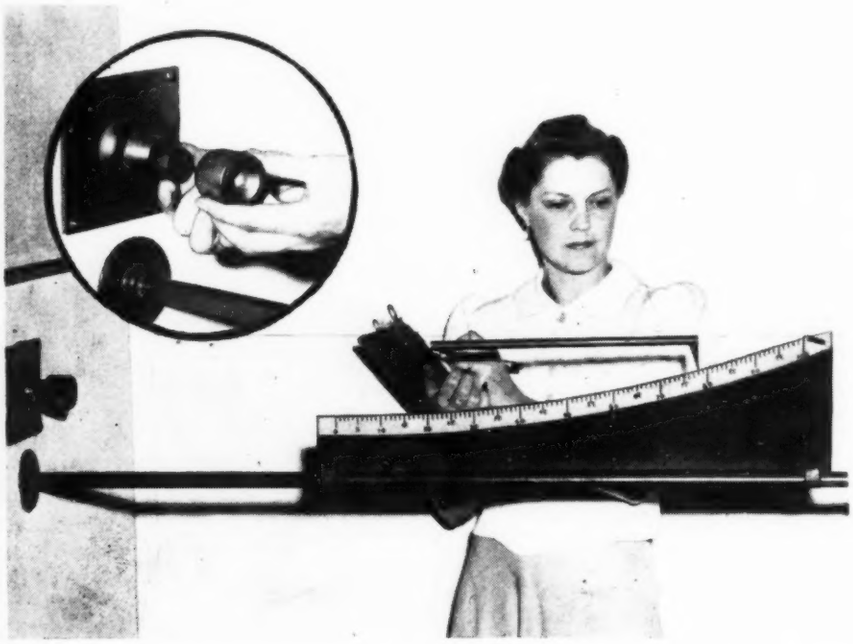
LUFKIN
SAGINAW, MICHIGAN — New York City
TAPES • RULES • PRECISION TOOLS

"Bouncer" Tests Resiliency of Synthetic Rubber

They aren't making rubber balls during these war days, but the quality of Hycar synthetic rubber must undergo a "bouncing" test just the same in order to determine its resiliency and its adaptability to many applications.

Compounds that are to be made into products that must absorb impact or shock should, when subjected to the "bounce" test, indicate a low rebound. On the other hand, synthetic compounds intended for such products as golf balls must show the highest possible rebound.

The method of testing resiliency is based on the rebound of a metal rod that is suspended like a pendulum and is released from a catch at a point marked 100 on the scale. The metal rod has a known weight and the rebound reading is taken when thermal equilibrium has been established in the sample. The point reached on the scale by the pendulum rebound is read directly in percent of energy recovered and the difference between this reading and 100 represents the percent of energy lost.



Making a Resiliometer test. Inset is close-up of test disk, anvil, and holder

In the accompanying picture a Hycar laboratory assistant is writing down the results of a rebound or resilience test on a Lupke Resiliometer.

The Hycar Chemical Company, producer of butadiene synthetic, Akron, Ohio, is jointly owned by The B. F. Goodrich Company and Phillips Petroleum Company.

Reorganize Safety Activities

Reorganization of the activities of the National Safety Council's industrial safety engineering division recently has been accomplished to provide more practical and specific assistance with accident and health problems in modern industry.

The new plan, which is in line with the general reorganization of the Council's program, makes full use of the industrial membership sections as centers for the accumulation and distribution of all safety information in their respective fields.

"It always has been recognized," says Walter S. Paine, vice president for industrial safety, "that the Council's safe practices pamphlets, industrial data sheets, engineering summaries, safety instruction cards, posters, and other technical materials are unique.

"Nowhere else can such a wealth of technical and practical information on industrial safety be found. The new goal of the industrial division will be to make certain that this information is kept up to date, that it fits the exact needs of those who will use it and that it is presented in the form that will be most helpful.

Each safety engineer on the staff has been appointed as staff contact man for one or more of the industrial sections. He has been assigned in accordance with his experience and knowledge of the industries in the sections.

As contact man the engineer is expected to work with the various subcommittees of the sectional executive committees on all sectional problems.

Receives "E" Award

The Tulsa Winch Manufacturing Corporation, Tulsa, Oklahoma, recently received the coveted Army-Navy "E" flag. At the ceremonies Lt. Col. R. W. Coward, executive officer of the St. Louis Ordnance District, commended the company on diverting its resources to war production without assistance from the government. Com. Nicholson, assistant public relations officer, presented "E" lapel pins to W. H. Patterson, machinist, who is the oldest employee of the firm from point of service.

Askania Wins "E"

H. A. Brassert, chairman of the board of directors of the Askania Regulator Company, presided as master of ceremonies of the Army-Navy "E" presentation held on October 26 at the 16th Street Armory, Chicago, Illinois.

The Army-Navy "E" award has been given to the Askania Regulator Company for the excellence of its performance in supplying automatic control equipment for war plants and special devices for the Navy.

Lt. Comdr. James L. Wisenbaker, U. S. N., presented the "E" pennant to the workers of the Askania Regulator Company and Major J. R. Weber made the presentation of the "E" pins.

H. J. Velten, president of the Askania Regulator Company, accepted the Army-Navy "E" award flag at the presentation.

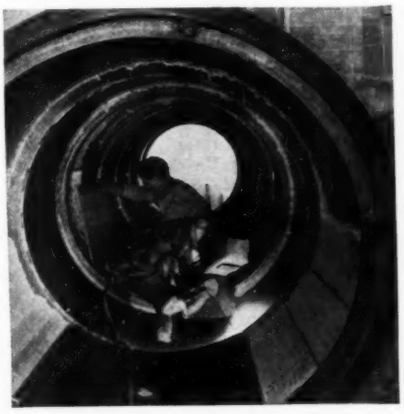
Add to Employee Thrift Plan

Employees of The Carter Oil Company and Oklahoma Pipe Line Company have been informed by their respective managements that they will receive their individual share of approximately $3,300,000 that the Standard Oil Company (New Jersey) and its affiliates are making as an additional contribution to increase credit balances in the employees thrift plan.

Every employee participating in the plan will receive a credit of $25. The balance of the three million dollars will be distributed on a proportional basis. Employees who have been granted a special leave of absence for military service will share in this distribution.

Under the provisions of the employees thrift plan any employee can authorize his employing company to withhold and assign to his credit in the fund not less than 3 percent nor more than 13 percent out of his pay envelope. The employing company adds to this payment dollar for dollar on the first 3 percent of the employee's earnings assigned to the fund and 50 cents more for each dollar above the 3 percent required for membership.

Insidline installations in pipe from 2" I. D. to 36" I. D. are made with a cartridge type of insulation that is built up first and then drawn into the pipe.



In larger diameters from 36" up to over 100", a panel type of Insidline is built up on the inside of the pipe.

Many new processes involve the piping of flue gases, steam, petroleum gases, hydrogen, and fluid catalysts at temperatures up to 1500° F., pressures up to 300 pounds, and velocities up to 500 feet per second.

Insidline, an internal insulation, was developed to enable ordinary carbon-steel pipe, with its comparatively light weight and low cost, to stand up under these conditions. The insulation holds the temperature of the piping to 750° F. or below, where the phenomenon of "creep" does not occur, and the pipe can be operated indefinitely at the usual stress allowances. The use of Insidline simplifies pressure-piping design, too, by reducing the number of expansion joints, bends, and other provisions for pipe expansion.

If you have a high-temperature, pressure-piping problem, it will pay you to investigate Insidline.

Send for descriptive booklet.

BALDWIN-HILL CO.

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NEW YORK, N. Y. • CHICAGO, ILL. • KALAMAZOO, MICH. • HUNTINGTON, IND.

WATER—FOR SOME NINETY-MILLION PEOPLE

Building Well Water Systems for world-wide use has been a gigantic task—a task of innumerable and never before solved technical problems. Today, throughout the United States, Canada, Mexico, England, North Africa and in many other foreign lands, Layne Wells and Pumps are supplying the daily water needs of at least ninety million people. Installations have been made in virtually every type of earth formation found on and under the face of the globe—many in which the efforts of other water developers have long been unsuccessful.

Layne engineers, drillers, pump builders and water developing technicians today are recognized as the world's most widely experienced—and the world's most successful.

Layne's knowledge, experience and proven ability constitute the finest recommendation existent for present war—and future peacetime needs. No other water developing organization on the face of the globe can equal that claim.

For illustrated literature on Layne Pumps, Layne Wells or complete Layne Well Water Systems, address Layne & Bowler, Inc. General Offices, Memphis 8, Tenn.

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minnesota, Minneapolis, Minn. ★ International Water Supply Ltd., London, Ontario, Canada.

LAYNE

WELL WATER SYSTEMS

DEEP WELL PUMPS

Builders of Well Water Systems for every Municipal and Industrial Need

New Sales Manager Superior Engine

The National Supply Company has announced the appointment of R. M. Pearson as manager of sales, Superior Engine Division.

R. M. PEARSON

Pearson has been affiliated with The National Supply Company since 1936 in the capacity of sales representative serving the marine trade and the inland waterways. He as been actively engaged in the sale of diesel engines for the last 20 years and served on the sales staffs of Fairbanks, Morse and Company, General Motors Corporation, and American Locomotive Company prior to his service with Superior.

Before entering the diesel field, Pearson was prominent in engineering circles in the Pittsburgh area in a designing and executive capacity.

Los Angeles Nomads Hear About Russia

A discussion of the prospects of the Russian conference and motion pictures of military action in all theaters of war were the highlights of the regular monthly dinner meeting of the Los Angeles Chapter of Nomads.

After opening the meeting, Henry Pullman, president of the Los Angeles Chapter, led in the Pledge of Allegiance to the Flag and then turned the meeting over to the master of ceremonies for the evening, Ralph Clemmons.

Hi Cassidy served as master of ritual for the induction of two new regular and one associate member, B. M. Landis, H. H. Peters, and H. F. Schlittle, respectively, and, with the assistance of a number of members present, conducted one of the wittiest initiation ceremonies ever put on by the chapter. W. J. Williams, who had been elected a regular member, was not in town and could not be inducted.

The speaker of the evening was Dr. Thomas Harris, national secretary of the Council of Soviet Friendship, who spoke on "What Does Russia Want?" This discussion was "down-to-earth" and left out all sentimental and sloganistic material that usually accompanies talks on war aims. This was followed by a moving picture entitled "The Bombing of Tokio," which actually showed scenes of fighting on land and sea in the Pacific, in Africa, and in Sicily.

There were 75 members and guests present at the meeting and among those from foreign countries were M. H. Hobbs for the N.K.P.M. formerly in the East Indies; Johnny Aston of Ultramar from Argentina; Ray J. Towsey of Cia Consolidada de Petroleo from Venezuela; A. F. Driskill of Iraq Petroleum Company from Iraq, and H. F. Brewen of I.P.C. from Peru. C. E. Whitney of the Houston Chapter was also a visitor.

Votator Vice President

Announcement was made recently of the election of John E. Slaughter, Jr., to the vice presidency of the Votator division of the Girdler Corporation of Louisville, Kentucky. For the last five years he has been sales manager.

J. E. SLAUGHTER

Starting in the New York office in 1934 as a salesman, Slaughter gained his first experience with Votator in its application to the ice cream industry.

He is a graduate of Male high school in Louisvillie, and of the University of Virginia.

A.G.A. Officers

At the recent meeting of the American Gas Association in St. Louis, Missouri, Ernest R. Acker, president, Central Hudson Gas and Electric Corporation, Poughkeepsie, New York, was elected president; J. French Robinson, president, The East Ohio Gas Company, Cleveland, Ohio, vice president, and J. L. Llewellyn, insurance manager, The Brooklyn Union Gas Company, Brooklyn, New York, treasurer.

Directors elected for two-year terms were:

F. M. Banks, vice president, Southern California Gas Company, Los Angeles, California; Walter C. Beckjord, executive vice president, Columbia Gas and Electric Corporation, New York, New York; C. M. Cohn, president, Consolidated Gas Electric Light and Power Company of Baltimore, Baltimore, Maryland; Watson E. Derwent, vice president, Geo. D. Roper Corporation, Rockford, Illinois; R. L. Fletcher, vice president, Providence Gas Company, Providence, Rhode Island; D. A. Hulcy, president, Lone Star Gas Company, Dallas, Texas; E. P. Noppel, Ebasco Services, Inc., New York, New York; Bruno Rahn, president, Milwaukee Gas Light Company, Milwaukee, Wisconsin; Louis Ruthenburg, president, Servel, Inc., Evansville, Indiana; E. J. Tucker, director and general manager, Consumers Gas Company of Toronto, Toronto, Ontario, and H. Carl Wolf, president, Atlanta Gas Light Company, Atlanta, Georgia.

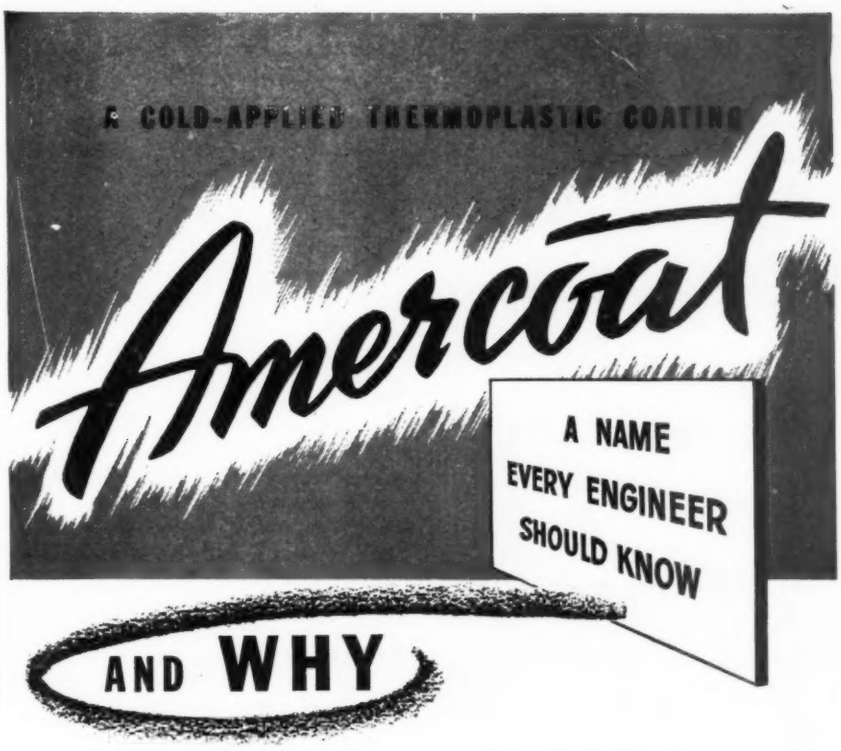
Change in Tulsa Office National Tube

Conversion of the Tulsa sales office of the National Tube Company into an independent district office was announced recently in Pittsburgh by National Tube Company, a subsidiary of United States Steel Corporation.

Earle E. Smith, of Tulsa, has been appointed district sales manager. Prior to conversion, the Tulsa sales office had operated under the Dallas, Texas, district.

An employee of National Tube Company for 20 years, Smith has been a field engineer in the Southwest during various periods since 1930. He was previously stationed in Tulsa from 1932 to 1934, returning to Pittsburgh as assistant superintendent of field work. In 1936 he became director of service. He lived in Dallas from 1939 to 1943, returning to Pittsburgh briefly last year. He again was assigned to Tulsa in April of this year.

E. H. Pelster and B. F. Collyer will serve as assistants to Smith. Office will remain at 1904 Philtower Building.



Don't wait until you are face-to-face with critical problems concerning corrosion and contamination. Get the facts about *Amercoat* now!

Amercoat protects metal, concrete and wood surfaces from corrosion by many different acids, alkalies and chemical compounds now required in the manufacture of vital war and food supplies.

Amercoat likewise, protects these same essential materials and food products from contamination by products of corrosion.

Thus, *Amercoat* does an important two-way job these days . . . equipment must be protected because replacements are hard to get . . . precious materials must not be wasted.

Amercoat is impervious to the corrosive action of such varied materials as: Aviation Gasoline . . . Sea Water . . . Ammonium Nitrate Alcohol . . . 40% Formaldehyde . . . Lactic Acid . . . 50% and 75% Caustic Soda . . . Concentrated Magnesium Chlorid Brine . . . Drinking Water.

EASY TO APPLY BY CONVENTIONAL METHODS

Amercoat compounds are inert thermoplastic coatings. When sprayed or brushed on metal, wood or concrete, they provide an impervious, odorless and tasteless surface. Ordinary industrial spray painting equipment can be used for application.

Get the facts about *Amercoat* now. Tell us your problem . . . and we'll show you how to solve it with Amercoat . . . or tell you frankly *Amercoat* isn't the answer.

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AMERICAN PIPE & CONSTRUCTION COMPANY
P.O. BOX 3428, TERMINAL ANNEX • LOS ANGELES, CALIF.
Canadian Dist.: Gunite & Waterproofing, Ltd., 180 Vallee Street, Montreal

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√ Pumps

Type No. 270. Designed especially for gas compressors. France Metal "Full-Floating" Packing is outstanding for its long wearing qualities. Eliminates frequent shut-downs.

Type No. 190. Designed for shallow stuffing boxes. Prompt delivery assured.

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Mid-Continent Representative:
MR. J. M. FULLER, 3725 W. 7th St.
FORT WORTH, TEXAS

Original **FRANCE METAL PACKING**

Named Advertising Manager

Dean Rollans, vice president in charge of sales, Wickwire Spencer Steel Company, has announced the appointment of Charles B. Konselman, as advertising manager.

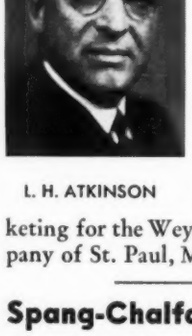
Konselman succeeds George L. Randall, recently commissioned a lieutenant (jg) in the U.S.N.R. and now stationed temporarily at the Naval Air School, Quonset Point, Rhode Island.

Prior to joining Wickwire Spencer and for the last six years, Konselman was associated with the Royal Typewriter Company, the last three years of which he was sales promotion manager.

Konselman was graduated from Columbia University in 1931, after which he studied business administration in the graduate school and has continued his specialized business study and practice since this time.

He will make his headquarters at the company's home office, 500 Fifth Avenue, New York, New York.

Vice President Elastic Stop Nut Corporation



L. H. ATKINSON

Luther H. Atkinson has been appointed vice president of the Elastic Stop Nut Corporation of America, it is announced by William T. Hedlund, president. Atkinson was formerly vice president in charge of marketing for the Weyerhaeuser Sales Company of St. Paul, Minnesota.

Spang-Chalfant Changes

Spang-Chalfant, Pittsburgh, Pennsylvania, announces as of November 1, the following changes in its field organization:

H. G. Texter returns to his former headquarters, Tulsa, Oklahoma, to resume his activities as chief field engineer.

George M. Eaton, who for many years represented the company as field engineer in California, with headquarters at Los Angeles, has retired and is succeeded by James A. Kennedy, transferred from Tulsa to Los Angeles.

N. A. Rebarick, who during the last several years has held various positions in the operating department at the company's seamless tube mills at Ambridge, Pennsylvania, succeeds Kennedy as field engineer, making his headquarters at Tulsa.

Tube Borium Keeps 'em digging

DULL IN 3 DAYS
STILL SHARP AFTER 30 DAYS
STOODY TUBE BORIUM* KEEPS DITCHER TEETH SHARP ...ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES...CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 3/16", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

STOODY COMPANY
1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear... Eliminate Repair

When the Lining of Your Stomach is Coated, the action is sluggish.

When Boilers and Tubes are scale and corrosion coated, you use more fuel, get less power, and shorten equipment life.

SAND-BANUM

Automatically

Removes and Prevents Scale and Corrosion While Your Equipment Operates

"The Entirely Different Boiler and Engine Treatment"

Guaranteed Absolutely Harmless to Personnel and Equipment, this outstanding product aids your equipment to consistently perform the way its builder intended; the way you desire.

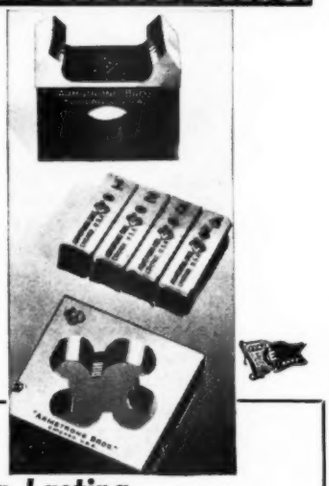
GET THE FACTS

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza, New York City, 20

Look for the Arm-and-Hammer

ARMSTRONG BROS.



Long Lasting
DIES and CHASERS

ARMSTRONG BROS. Pipe Dies and Chasers make pipe threading easier, cut smoother, closer fitting threads and hold their keen edge longer because of important design improvements, superior material and modern controlled manufacturing methods. All have the correct Cutting Angle, the correct Throat Angle and provide Ample Chip Clearance. All are machined from Special Vanadium Tool Steel, carefully hardened, drawn, tempered and tested.

Armstrong Bros. Dies fit all standard makes of stocks and threaders.

Write for catalog C-39a for complete showing and description of Armstrong Pipe Dies and Chasers.

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
331 N. FRANCISCO AVE. CHICAGO, U.S.A.
Eastern Warehouse & Sales: 199 Lafayette St., New York

Terbell Promoted

The appointment of Joseph B. Terbell as first vice president of the American Manganese Steel Division of the American Brake Shoe Company has been announced by the company, with which he has been connected for 15 years.

J. B. TERBELL

Terbell was born in 1906 and graduated from the Sheffield Scientific School of Yale University in 1928. In October, 1928, he joined the American Manganese Steel Division. In 1940 he was appointed a vice president and now has been made first vice president.

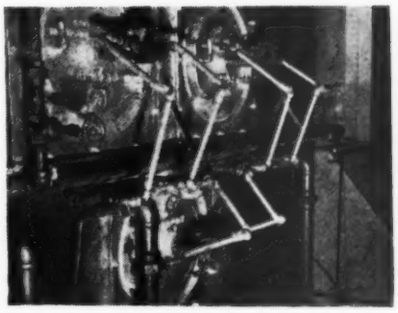
Gardner-Denver Appointments

R. H. Rodolf has been appointed manager of the Pump and Compressor Division of Gardner-Denver Company, Quincy, Illinois, following the death of R. J. MacFarland. Rodolf's connection with the company dates back to August, 1917, when he joined the Canadian Rock Drill Company at Vancouver, B. C., then a subsidiary of the Denver Rock Drill Manufacturing Company of Denver, Colorado. In 1926, he was transferred to the St. Louis office as district manager. He continued in that capacity after the merger of the Gardner Governor Company and the Denver Rock Drill Manufacturing Company and was transferred to Quincy in 1939 as assistant manager of the Portable Compressor and Rock Drill Division.

Appointed as Rodolf's assistant is C. M. George, who joined the Gardner-Denver organization in Quincy in January, 1929. With the exception of a few months spent in the armed forces with the U. S. Engineers, George's service with Gardner-Denver has been continuous in Quincy. Up to his recent appointment as assistant manager of the Pump and Compressor Division, he had been connected with the general sales department of the Gardner-Denver Company.

Leschen Promotions

A. Leschen and Sons Rope Company, St. Louis, Missouri, has announced the appointment of R. P. Tyler as general manager of sales, and C. R. Deam as assistant manager of sales.



FLEXIBILITY
THAT DOESN'T DRY UP UNDER HEAT . . . . .

The necessity of maintaining flexible lines on boiler room equipment and in other places where high temperatures are encountered raises a serious problem . . . particularly in these days of critical shortages of vital materials.

CHIKSAN offers a solution to this problem which has proved its practicability in installations such as that shown above, in which Chiksan High Temperature Swing Joints are used to provide necessary flexibility on fuel lines to industrial burners.

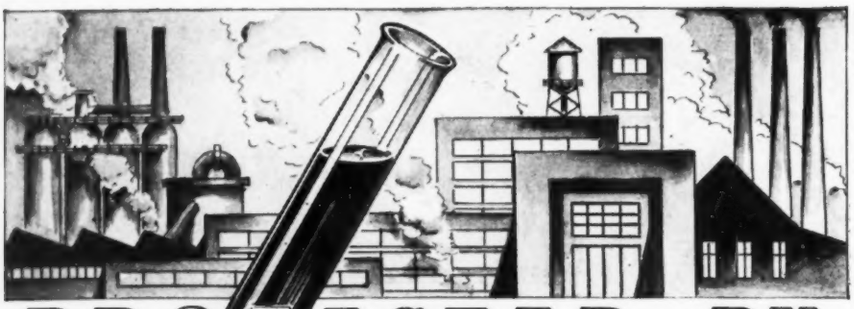
STYLE 30 CHIKSAN HIGH TEMPERATURE SWING JOINT.

CHIKSAN High Temperature Swing Joints withstand temperatures to 700°F. and pressures to 500 lbs. The packing is not affected by chemicals which are injurious to rubber or synthetic compounds. Supplied in ½" to 4" sizes, with threaded or flanged ends or bored for welding. Other types for pressures to 3,000 lbs. and 225°F. Over 500 different Types, Styles and Sizes to choose from.

CHIKSAN REPRESENTATIVES IN PRINCIPAL CITIES.

DISTRIBUTED NATIONALLY BY CRANE CO.

CHIKSAN TOOL COMPANY
BALL BEARING SWING JOINTS for ALL PURPOSES
BREA, CALIFORNIA
ALL-STEEL ROTARY HOSE CIRCULATING HEADS · MUD GUNS



PROTECTED BY
HAERING GLUCOSATES

Protect your plant against corrosion, the destroyer of piping systems, boilers and condensers. Corrosion scale retards heat transfer and lowers efficiency. Call in a Haering engineer without obligation, and let him show you how Haering Glucosates save you money and increase production. Or write for these booklets . . .

"Organic Methods of Scale and Corrosion Control"
"Water Studies"
"Water Treating"

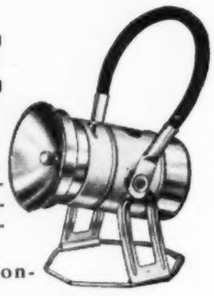
WE READ WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES
205 West Wacker Drive Chicago, Illinois.

You're "Safe"
When You Carry
90-UL
ECOLITE

Don't wait — get this new Safety Lantern with BROKEN BULB EJECTOR!

SAFE
in Hazardous Places



Ecolite No. 90-UL

Tested and Recommended by Underwriters' Laboratories.

- Sealed beam construction.
- Throws bright beam 1500 feet.
- Large handle and pivoting feature gives you light where you need it and both hands free for work. Now at jobber and supply stores.

Economy Electric Lantern Co.
3100 W. Cherry Street Milwaukee 8, Wis.

GET ACCURATE RESULTS
Quickly . . Easily . . with
CURTIN CENTRIFUGES

No. 3480. 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

W·H·CURTIN & CO. Inc.
HOUSTON U.S.A. TEXAS

J. M. Dolan Promoted

Le Roi Company, Milwaukee, Wisconsin, has announced the appointment of John M. Dolan as general sales manager. Dolan has a background of long experience in the machinery sales field.

J. M. DOLAN

After graduating from the Northwestern University School of Engineering in 1927, he joined the Dryden Rubber Company in Chicago where he worked until 1930.

He then became associated with the Sullivan Machinery Company in the General Sales Division. After this he was made assistant to the general manager of the western plant of that company. For the last five years he was manager of the Sullivan Compressor Division, supervising both engineering and sales.

Campbell With Clark Bros.

J. B. O'Connor, vice president, of Clark Bros. Co., Inc., Olean, New York, announces that Arch F. Campbell has joined the company as sales engineer.

ARCH CAMPBELL

After his graduation from the University of Michigan in mechanical engineering in 1918, he served a year as a flying officer in the Army. He then joined the production department of Phillips Petroleum Company, subsequently becoming associated with Waukeska Motor Company as branch manager in charge of oil field sales.

Prior to joining Clark Bros. Co., Inc., he has for the last two years been manager of sales of the Superior Engine Division of the National Supply Company.

Campbell will have his headquarters in Tulsa, Oklahoma.

Bethlehem Opens Store

Bethlehem Supply Company, Tulsa, Oklahoma, has opened a new store at Kermit, Texas, under the direct supervision of R. E. Throckmorton, district manager, who makes his headquarters at Odessa. C. L. Richardson is store manager and field representative, and C. M. Stice is assistant store manager.

Precision Gauge Industry Develops on West Coast

Backed by years of preparation and study, manufacture of precision ring, plug, and special types of gauges is now a fast-growing west coast industry, supplying an important share of war requirements for such tools.

As late as 1940, Kobe, Incorporated—original manufacturers of hydraulic pumping equipment—discovered that scarcity and delayed deliveries of gauges were definitely hindering the

A few of the different types of gauges manufactured in Kobe's modern plant

smooth flow of western industrial production. After a particularly long wait for a special type of gauge that they themselves required, Kobe officials decided to manufacture their own. Selecting trained mechanics already employed in the regular precision operations of its shops, the company began making gauges needed in the manufacture of hydraulic oil well production equipment. Originally, the work was done with but two men; today, there are 54 employees working three shifts a day making the highest quality master and reference gauges, which are shipped to war plants throughout the United States.

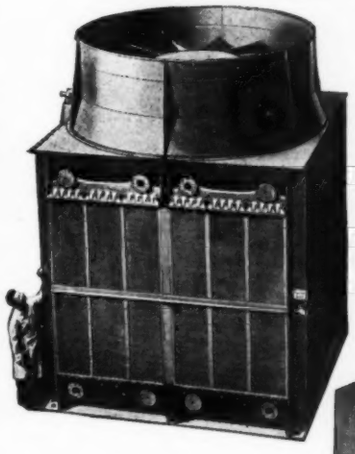
The first item produced was an electric gauge for determining maximum accuracy limits. This was designed originally for the diametric and concentric check of hydraulic pump liners, which were 4 and 5 ft. in length. Continued improvement, however, developed a gauge that checks accurately these liners in lengths up to 25 ft.

The plant is equipped throughout with air conditioning for temperature, dust, and humidity control.

Testing equipment includes two Pratt and Whitney standard measuring machines with 3 ft. capacity, as well as three specially designed and constructed Kobe measuring machines. Two of these Kobe units are for measurements up to 12 in. The third is one of the largest in the country. It is a finely constructed instrument used for measuring units up to 14 ft. in length. This unit has played an important part in the calibration of the gauges required to produce the first 5 in. guns manufactured on the Pacific Coast. Dimensions of gauges are also checked by light waves. Using optical flats, which are true within one millionth of an inch, absolute accuracy is constantly maintained through every step of manufacture, it is pointed out. The plant also boasts of one of the few optical dividing heads on the Pacific Coast. This machine is used for controlling diametric and concentric accuracy. It divides a circle into a millionth part for absolute checking of dimensions.

Most of the production is for war needs, but the facilities of the plant subsequently will be available for west coast industrialists. Even today, working with new materials, Kobe executives have devoted considerable thought to adaptation to peace-time needs.

Young Units for ENGINE-COMPRESSOR Installations



Young Quad Cooling and Condensing Towers maintain the jacket water and lube oil of large engines and compressors at suitable operating temperatures . . . radiator type units offering the many advantages of closed system cooling. Also for the cooling of compressed gases and vapor condensing.

Young Evaporative Coolers and Condensers may be used as complete units or in conjunction with Young Quads, to obtain temperatures below the ambient dry bulb. Operating costs and make-up water requirements are held at a minimum with these highly efficient units.

Largest of the Young atmospheric type units, Quad Towers will handle the heat rejection load of entire compressor systems. A single unit can be so constructed that it will accommodate the jacket water and lube oil of both the driving internal combustion engine and the driven compressor — and cool gases after both intermediate and final compression stages. For larger installations, each of the liquids and gases will require separate units or batteries of units. When temperatures below the ambient dry bulb must be obtained, Young Evaporative Coolers can be employed as complete units or be used in combination with Quad Atmospheric Cooling Towers. Both of these Young units embody special patented features . . . the result of continuous research and field observation. Write for complete engineering data on their application in your compressor systems.

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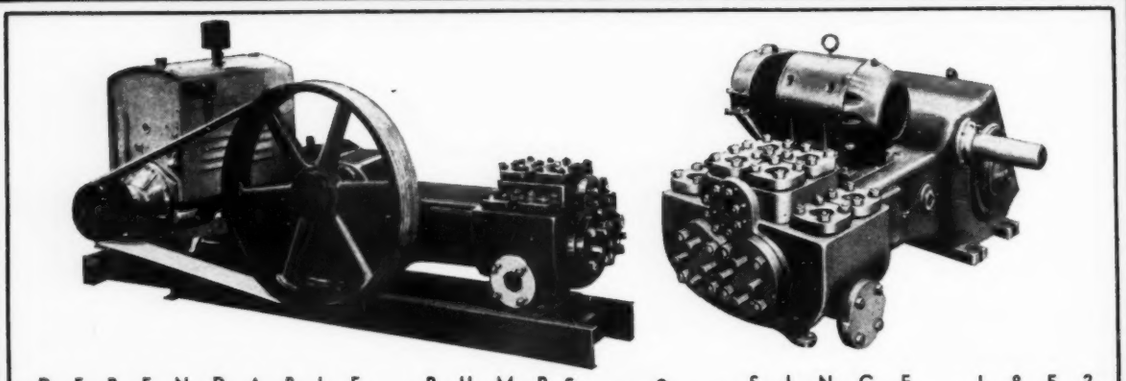

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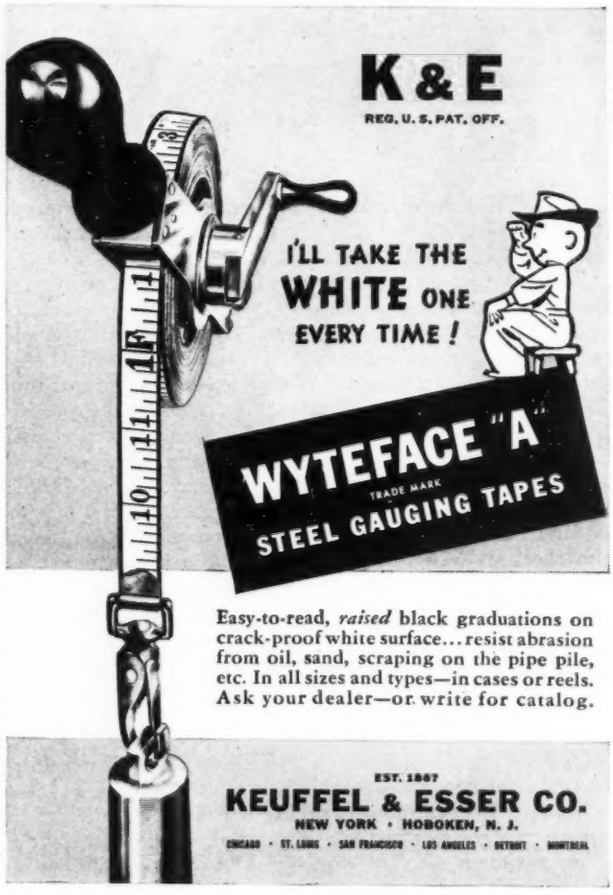

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TRADE LITERATURE

What to Write For

SYFO CLINOGRAPH is now obtainable from Sperry-Sun Well Surveying Company, 1608 Walnut Street, Philadelphia, Pennsylvania, on a daily, six months, or yearly rental basis instead of the former yearly basis. The new Syfo rental price list SY-43, giving full details, will be sent upon request.

LITERATURE on Layne pumps, wells, or complete well water systems has been prepared to send to those interested. Internationally known as builders of water well systems, Layne's booklets contain valuable information on that subject. Address Layne and Bowler, Inc., Memphis 8, Tennessee.

THE HYATT ROLLER BEARING MAINTENANCE HANDBOOK is just off the press and ready to send to those requesting a copy. Full, illustrated directions are given in a direct, simple manner so that they may be easily followed. Requests should be sent to Department 204, Hyatt Bearing Division, General Motors Corporation, Harrison, New Jersey.

ADVANTAGES of twin G-Fin sections are explained and experiences recounted in Bulletin 1613 of The Griscom-Russell Company, 285 Madison Avenue, New York, available upon request. Known as the "Universal Heat Exchanger," the twin G-Fin sections are used in a great variety of services.

IMPROVED METHODS of pumping water from deep wells are described in a new pump bulletin issued by Peerless Pump Company, 301 West Avenue 26, Los Angeles 31, California, who will supply copies upon request. Interesting cross-section views of deep well pumps, revealing the shafting and submerged pump elements, demonstrate the operation of lifting water from any depth.

A NEW 4-PAGE BULLETIN, No. 201, presents in concise form the full Ransome line of welding positioning equipment: Specifications, load rating tables, dimensions, etc. Copies may be obtained by addressing the Ransome Machinery Company, Dunellen, New Jersey.

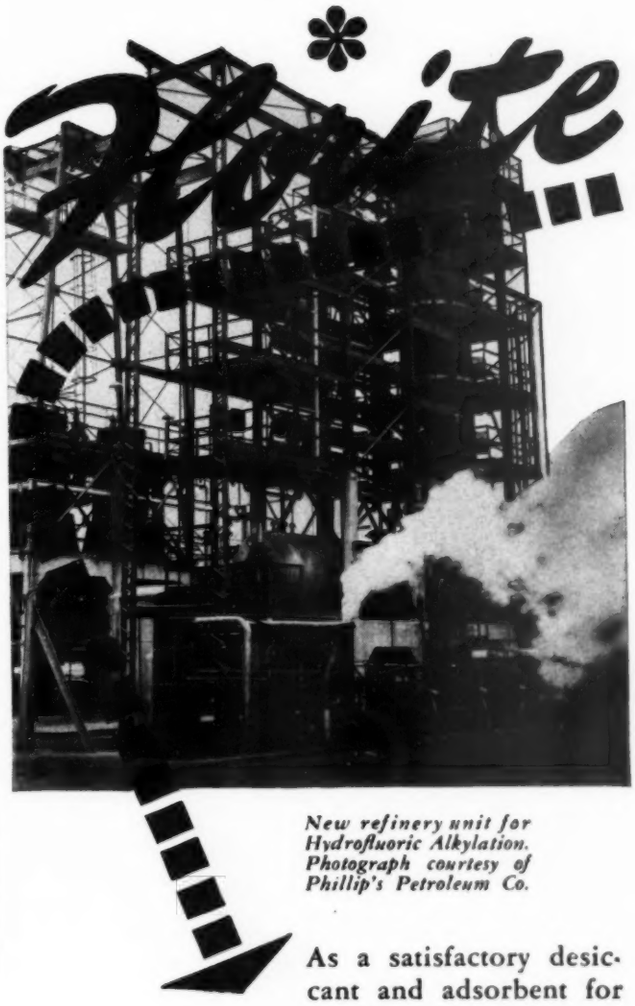
BETTER VALVES CATALOG No. 101 has been published by The Edward Valve and Manufacturing Company, 1592 West 145th Street, East Chicago, Indiana. Copies will be sent on request. The booklet contains descriptions and illustrations of the numerous types of steel valves made by Edward.

DETAILED INFORMATION on how to build and equip a power plant tailored to individual needs will be sent to those who state their requirements to Climax Engineering Company, Clinton, Iowa. Bulletins that cover each Climax engine, its uses, performance curves, specifications, etc., are available.

A BEAUTIFUL BROCHURE giving the 25-year history of The Refinery Supply Company, Tulsa, Oklahoma, has just been released. Drawings point up the progress of the firm and depict the modern and accurate measurement precision instruments produced under the AC-ME trademark. Copies are available.

WESTCO INDUSTRIAL PUMPS CATALOG No. 43 has just been issued and copies are available. The 60-page volume carries pictures, descriptions, and tables on virtually all products of Joshua Hendy Iron Works, Pomona Pump Company Division, 206 East Commercial Street, Pomona, California.

Hydrofluoric Alkylation makes important use of



New refinery unit for Hydrofluoric Alkylation. Photograph courtesy of Phillip's Petroleum Co.

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Book Reviews

Cameron Hydraulic Data, edited by G. V. Shaw and A. W. Loomis. Published by Compressed Air Magazine, Bowling Green Building, New York City. Pages, 240. Price, $3.

This handy reference on the subjects of hydraulics, steam, and water vapor has proved its value and this is the eleventh edition as well as the largest. Many portions of "Cameron Hydraulic Data" have been revised and augmented. The sections dealing with flow of liquids in pipe have been enlarged and entirely recalculated and should greatly facilitate the handling of problems dealing with liquor flow.

●

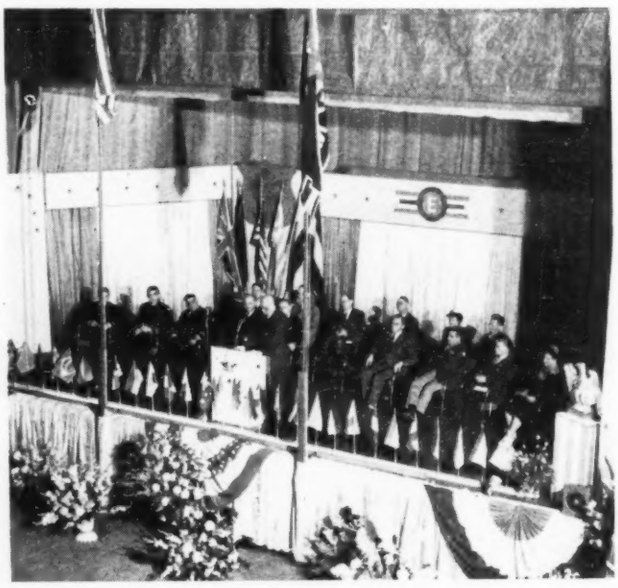
Gas Chemists' Book of Standards for Light Oils and Light Oil Products, by V. J. Altieri. Published by the American Gas Association, 420 Lexington Avenue, New York, New York. Pages, 352.

Gathering of the valuable material in this volume is the result of a project by the Subcommittee for Revision of the Gas Chemist Handbook, created in 1940 by the Chemical Committee of the American Gas Association. On account of the war there was a demand for a simplified handbook that could be assimilated by the great army of technicians who had no time for usual years of training. The special need for information about light oil products expanded this particular chapter into such large proportions that Altieri, chief chemist for Eastern Gas and Fuel Associates, was invited to prepare a comprehensive record of fundamental standards on matters relating to the production and use of light oils.

It is difficult to assess the importance of an authoritative book of standards for light oils and light oil products at this time. Assembling useful and necessary information and presenting it concisely is a work that will have far-reaching influence. It will be useful in training new technicians, aid in expediting processes, conserve essential materials and standardize specifications, tests, and facilities.

●

"E" Award Ceremonies



Scene of the impressive ceremony attending presentation of the Army-Navy "E" award to the Twin Disc Clutch Company, Racine, Wisconsin. Assembled employees and guests heard addresses by Capt. Logan McKee, U. S. N. Bureau of Ships and P. H. Batten, president of the company.

MEETINGS

American Society of Mechanical Engineers, Annual Meeting—November 29, 30-December 1, 2, and 3, Hotel Pennsylvania, New York, New York.

New Mexico Oil and Gas Association, Annual Meeting—December 1, Carper Terrace, Artesia, New Mexico.

California Natural Gasoline Association, Monthly Meeting—December 2, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

Exposition of Chemical Industries—December 6, 7, 8, 9, 10, and 11, Madison Square Garden, New York City.

Interstate Oil Compact Commission—December 10 and 11, Broadview Hotel, Wichita, Kansas.

San Joaquin Valley Oil Producers Association—December 29, Hotel El Tejon, Bakersfield, California.

Society of Automotive Engineers, Annual Meeting—January 10, 11, 12, 13, and 14, Book-Cadillac Hotel, Detroit, Michigan.

American Institute of Mining and Metallurgical Engineers, Annual Meeting—February 20, 21, 22, 23, and 24, Waldorf-Astoria, New York, New York.

American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Annual Meetings—March 22 and 23, Dallas, Texas.

Petroleum Industry Electrical Association and the Petroleum Electric Supply Association—Last week in April, 1944, Dallas, Texas.

American Association of Oil Well Drilling Contractors, 1944 Meeting—Fort Worth, Texas, date to be announced.

Statement of the Ownership, Management, etc., of
THE PETROLEUM ENGINEER
September 22, 1943

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Known bondholders, mortgagees and other security holders holding 1 per cent or more of the total amount of bonds, mortgages or other securities: None.

W. T. Bryan, Secretary-Treasurer.
Sworn to and subscribed before me this 22nd day of September, 1943.

Lillian Haddock Johnston, Notary Public.
(My commission expires June, 1945.)

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